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Fall 1973

South Dakota Farm and Home Research

Agricultural Experiment Station, South Dakota State University

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GOAL TENDING

86th
Annual
Report
Agricultural
Experiment
Station

South Dakota RESEARCH Farm & Home

Agricultural Experiment Station, South Dakota State University, Brookings. XXIV • Fall-Winter 1973 • Nos. 3-4

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New Associate Director

Raymond A. Moore

Raymond A. Moore, the new associate director of the Agricultural Experiment Station at South Dakota State University, is a native South Dakotan who has experience in teaching, research and administration. He took over his new duties last July 1 following the retirement of Alfred L. Musson.

Dr. Moore was born in Britton, S .D., graduated from Kidder High School, received his bachelor of science degree from SDSU in 1951 in agricultural education and economics, his M.S. degree from SDSU in agronomy in 1958, and his Ph.D. degree in agronomy from Purdue University in 1963. He was a staff member of the SDSU Plant Science Department and in 1969, he was named head of the department.

From the Dean and Director . . .

Goals Point Us in Desired Direction

GOALS are guidelines and serve to point us in the desired direction. In this 86th annual report of the South Dakota Farm & Home Research, summaries of Agricultural Experiment Station research are listed under the goal in which they are most closely associated. At least 70% of our research and resources are associated with the top 20 goals. These goals are rather broad and it is recognized that they may be interpreted in different ways.

Moving the corn belt north and west certainly does not mean that each year a block of corn is added to the north and west. It does mean that the acreage and yield of corn in South Dakota could increase. This goal is reasonable and attainable.

Corn is an adaptable crop. It can be manipulated by breeding and management so that it can be grown under varying climatic and soil conditions. It can be both a cash crop and a livestock feed, both important to South Dakota farmers and ranchers. Nevertheless, this goal as well as the others, needs to be reevaluated from time to time. Concerns that influence priorities change.

Today, America is aware of an energy crisis. "Overproduction," "surpluses" and "carry-over" are terms that within a twelve-month period have almost disappeared when discussing agricultural production. In a quest for abundant low-cost food, little concern has been given in the past to the amount of unrenewable sourcse of energy that have been consumed in meeting this demand.

Seeding, land tillage, pesticides, fertilizers, harvesting, drying . . . all require varying amounts of fossil fuels. Continuous cropping is especially demanding. Crop rotations with legumes require less pesticides and fertilizers.

We are fortunate that the scientists who conduct research have had the foresight to anticipate the future. This information is available and ready for use. The same leadership has kept us developing superior varieties and improved management systems even when grain bins were full. We now reap the rewards of their foresight. We depend heavily on their judgment in establishing goals. We also value the contributions from advisory groups, organizations and individuals. We solicit your contribution.—Raymond A. Moore.

Duane Acker,
Dean, College of Agriculture and Biological Sciences; Director of Extension; and Director, Agricultural Experiment Station

A. L. Musson,
Associate Director, Agricultural Experiment Station.

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South Dakota Farm & Home Research

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Serving the people of South Dakota through Teaching, Research, Extension

86th ANNUAL REPORT
(Period ending June 30, 1973)

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GOAL TENDING

The work of the Agricultural Experiment Station at South Dakota State University is largely based on goals or objectives which have been developed during the past years. Agricultural research, by its very nature, usually is a look into the future. The goals themselves must involve a constantly changing and evolving concept based partly on new knowledge and partly on problems that may be new or re-occurring.

The first 10 Agricultural Experiment Station goals were developed in 1967 and the second 10 were added later. The 20 goals are not only aimed at improving South Dakota Agriculture but they also serve as a medium for budget and priority setting. This does not necessarily mean, however, that the following goals or objectives are listed in a priority order.

Objective No. 1—Expand Production Belt of Corn to the North and West in South Dakota

South Dakota's corn production reaches toward the west and north mainly through development of tougher, more drought tolerant, and faster-growing hybrids.

Until techniques are perfected to bring in more controlled moisture from the sky, anything done to reduce the highly limiting factor of available moisture has an impact. This includes conservation, irrigation, and weed control. Seasonal day-length and temperatures combine to form another limiting factor which means producing short-season hybrids. In both the fringes and the main southeastern part of the South Dakota corn producing area, it is necessary to provide the grower with information to combat or control damaging insects and diseases, fertilizer needs and uses, tillage methods, best per-acre plant populations and row spacing, machinery, storage, marketing . . .

Expanding the production belt is a continuous effort involving many facets of agricultural research and actually was part of Agricultural Experiment Station research starting in the 1880's. Years ago, some South Dakota corn production and research was seen as providing seed for use elsewhere. Now, however, corn is mainly a basic feed for the state's billion-dollar-a-year livestock industry.

Specific Goals

Yield and quality improvement in superior field corn hybrids, obtained through development of inbred lines, are specific goals in SDSU corn breeding research. Three major factors contributing to yield being emphasized are proper maturity for high potential germ plasm, multi-eared and lodging resistance. Quality improvement stresses breeding for high lysine content and for possible development of hybrids with lower lignin content which would be of value where stalks are fed in such forms as silage. Many commercial hybrids adapted to South Dakota conditions now contain some inbred materials from the SDSU Agricultural Experiment Station.

Three new inbreds performed especially well in hybrid combinations last year. SD18 is a result of the two-eared selection program, SD24 comes from early line development using Gaspe Flint (for earliness) and SD28 is a recovered Iowa B8 (for better adaptability to South Dakota, especially disease resistance). The Plant Science Department has cooperated in a study by the Dairy Science Department involving effect of a specific gene when placed in adapted corn on lignin percentage and feeding value of silage fed to ruminants.

Disease control is another major effort to help the South Dakota corn grower which is of special importance in either higher production or in fringe areas. More details of results on root and stalk rot resistance as well as in monitoring Southern Corn Leaf Blight are included in Objective No. 13 on crop diseases.

New Tillage Research

Included in tillage experiments is one just started using a chisel plow for fall tillage to form good seedbeds for spring, to loosen soil for better moisture infiltration, to help control weeds, and to keep residues on the surface for erosion reduction. A problem of phosphorus placement is expected to intensify as this experiment progresses.

A wide variety of insects like South Dakota corn. Several approaches are being used in research to help the grower. Field surveys are conducted continuously throughout the growing season to spot infestations early enough to give crop producers time to take control measures and prevent excessive damage. Insecticide products —both commercial and experimental types—are tested to determine the most effective and economical ones for use under South Dakota conditions. Use of insect enemies or parasites plus breeding corns with insect tolerance are other methods. More details may be found under Objective No. 13 on control of crop pests.

Many Factors Involved

"Stretching" the corn belt north and west is based on the high adaptability of the crop—plant breeders have been able to manipulate the germ plasm and develop varieties that are highly productive under various conditions. Moving farther north and west provides a greater challenge. Corn is also versatile in its use. It is an excellent feed grain but it also may serve the same producer as a cash grain crop.

Expansion of the corn belt must be kept in proper perspective. Soils that are erosion prone should not be planted to this row crop. Good rotations must be followed to reduce the need for the use of pesticides and a legume should be a part of the rotation to reduce the need for the use of commercial fertilizer. Agricultural chemicals are important and often essential in productive agriculture but they are produced with critically short supplies of fossil fuels. Short season corns are necessary in order to reduce artificial drying. Propane, often used for drying, is another short-supply energy source.

Alfalfa is a legume that works in such a situation and is one of our protein rich feeds. Protein is a nutrient in great demand. The wise use of corn with alfalfa will accomplish many objectives.

Objective 1—A Long-Time Effort

EXTENDING corn production in South Dakota has been underway for a long time.

Archaeology studies indicate corn may have been a South Dakota "crop" nearly 5,000 years ago.

At first the outlook wasn't so good in recorded history:

> "In 1885 . . . the general belief was that corn could not be successfully grown, except for fodder, in this section [Brookings County] of Dakota . . ."
> and
> "There seems to be a very distinct dividing line running irregularly across the state, south of which corn is, and has been so considered from the beginning, an assured crop, all of the largest Dents maturing readily; but north of this line only the early Flints and the smallest of the Dents are to be considered reliable." — Bulletin 24, *Corn*, South Dakota Agricultural College and Experiment Station (1891).

But a few years later as experience and knowledge was gained through research:

> "The most important lesson to be learned . . . is to *raise corn*. If for no other reason than to put your land in good condition for raising wheat, raise corn. If proper care is given to the selection of seed corn and the crop is given the necessary culture and the grain is fed upon the farm, the corn crop will be a profitable one in nearly all parts of the state."—Bulletin 79, *Crop Rotation for South Dakota*, South Dakota Agricultural College, Experiment Station, May 1903.
> and
> "USDA crop estimates for 1915 show that the amount of corn raised exceeded the production of any other grain crop by 20,000,000 bushels . . ."
> and
> "South Dakota is peculiarly adapted to supply seed corn to the states north and west . . ." both foregoing quotes from Bulletin 181, *Corn Culture in South Dakota*, Agricultural Experiment Station, South Dakota State College of Agriculture and Mechanical Arts, March 1918. This publication included a photo of Mitchell's Corn Palace as well as a photo of Old Man Yellow Lodge of the Standing Rock Indian Reservation, who was designated as one of South Dakota's first corn growers.

Then came hybrid corn that started a revolution in U. S. corn production—

The late A. N. Hume, one of SDSU's top agronomists and plant breeders, in 1919 discussed ". . . expedients [which] may be employed in securing the production of seed corn, which is the product of crossing strains that are selected for high yield (or any quality), that are selected continuously and whose sires and dams may have approached a homozygous condition." — Bulletin 186, *Corn Families of South Dakota*, Agricultural Experiment Station, South Dakota State College, August 1919.

Later, Hume wrote of his long interest in hybridization of corn and mentioned a 1910 national publication on the subject in connection with his publication on *The Possibility of Utilizing Selfed Strains in Practical Corn Improvement*, Bulletin 245, Agricultural Experiment Station, South Dakota State College. In that publication he summarized: "Hybrid vigor has been recognized . . . the difficulty in making practical use of it has not been lack of acquaintance with the principle itself, but of finding and outlining a way to utilize it."

Corn hybrids started coming into their own during the 1940's in South Dakota. *The 1942 South Dakota Hybrid Corn Yield Test* stated that reluctance to change from open-pollinated corn varieties to hybrids ". . . has been due primarily to the difficulty of ascertaining the hybrids which will produce the largest average yield under the extremely variable climatic conditions . . ." The purpose of the yield tests were to ". . . supply information to the purchaser of hybrid corn seed which will enable him to choose adapted high yielding hybrids for his area, and also to provide the producer of hybrid strains with the data necessary to the development of better combinations." — Circular 45, Agricultural Experiment Station, South Dakota State College, April 1943.

During the past 20-year period county yield averages have increased from 13 to 45 bushels an acre—in the 1950's most yields averaged around 20 bushels an acre and in the 1970's most yields averaged between 40 and 65 bushels an acre.

Of additional interest is the fact that corn is grown in every South Dakota county—even in the northwesternmost. Acreage is small in some counties but all 67 of them are included in official crop reports, according to *South Dakota Agriculture 1972*, South Dakota Crop and Livestock Reporting Service.

Although considered on the "fringe" of the Corn Belt, nevertheless South Dakota's corn crop harvested for grain had a farm value of $168,115,000 from production of 152,832,000 bushels in 1972. This is nearly a third—and the largest single crop—of the total half-billion-dollar-plus value of all crops produced in the state.

Last year South Dakota ranked 9th in U. S. corn production by states. USDA estimates (August) of indicated production for 1973 is 141,780,000 bushels for South Dakota, which drops the state to 10th rank behind Kansas which got into the top 10 production states this year by replacing Michigan. According to the USDA estimates, Iowa will retain No. 1 place in U. S. corn production with an indicated total in 1973 of 1,181,900,000 bushels.□

Objective No. 2—Expand the Winter Wheat Belt Northward

TRADITIONALLY the winter wheat belt has centered in Kansas, extending into Nebraska and South Dakota. The spring wheat belt swings up into Canada from the northeastern quarter of South Dakota. In other words, South Dakota is on the fringe areas of both winter and spring wheat.

To a large extent stem rust and competition with crops such as barley, corn and flax, has limited expansion of the spring wheat belt while winters were too severe for intensive northern expansion of winter wheat.

However, research providing better adapted new varieties with resistance to major disease — especially rust—along with new cultural practices and equipment have contributed to better chances of success in growing winter wheat in the somewhat more severe environment of South Dakota. Average yields of winter wheat are greater than those of spring wheat. It is for these reasons that one major Agricultural Experiment Station goal is to extend the traditional winter wheat belt northward, especially into northwestern South Dakota where the relatively mild winters and hot summers are conducive to use of fall-seeded wheat to be harvested the following summer. Of course, it has always been true that the better winter wheats have been sporadically grown in the state's northeastern area in mild winters and recently with deep furrow drills that pack the soil around the seed.

South Dakota ranked eighth in the nation for all wheat production in 1972 with 53,619,000 bushels having a total farm value of $85,426,000 which is 17% of total value of all crops. The state's winter wheat production in 1972 was 25,380,000 bushels (ranked 14th nationally) with farm value of $38,831,000.

Range of Production

Winter wheat and spring wheat production in South Dakota during the past 20 years has ranged from a high of 73,892,000 bushels in 1967 to a low of 16,537,000 bushels in 1956 with an average of 41,760,000 bushels. Winter wheat production during that period ranged from 29,916,000 bushels in 1967 to 4,121,000 bushels in 1956 with the average at 14,031,000 bushels. Spring wheat production at least for the past 20 years has been greater than that of winter wheat (see more about spring wheat under Objective No. 11 concerning development of spring small grain varieties).

Winter wheat is generally more convenient to seed, has a longer time (overwinter and early spring) in which to make maximum use of limited moisture and mature ahead of the hottest, driest summer weather. Although fall planting may be "stretched" out over a longer period, planting too early may bring problems with wheat streak mosaic which is transmitted by a tiny mite from other host plants later in the season to growing wheat (See Objective No. 13 for control of crop pests).

	1972 Harvested Acres	Average yield bu/A	Total Production Bushels	Farm Value	Value Bushel Harvested	No. counties reporting production out of 67
All wheat	1,878,000	28.6	53,619,000	$85,426,000	$1.59	67
Winter wheat	705,000	36.0	25,380,000	$38,831,000	$1.53	63
Spring wheat	1,173,000	24.1	28,239,000	$46,595,000		
Durum wheat	87,000	25.0	2,175,000	$ 3,589,000	$1.65	64
Other spring wheat	1,086,000	24.0	26,064,000	$43,006,000	$1.65	67

(Data from: South Dakota Crop and Livestock Reporting Service)

Efforts began early in the state's history to develop better wheats. In fact the first annual report of the "U. S. Agricultural Experiment Station for Dakota" in 1888 named some 20 varieties which were in experimental plots. By 1890 early results with spring wheat detailed problems with hot summer winds and advantages of drill-planting or broadcast planting. Yield averaged about 25 bushels to the acre (on small plots or small fields). The 1890 report on winter wheat acknowledged problems of drought, damage by ground squirrels, but the wheat ". . . wintered well and there was little or no damage from the freezing and thawing of spring." Smuts and rusts were a problem. Yields ranged from 25 bushels an acre on "new bottomland" to from 1 to 10 bushels an acre on "old, well manured uplands."

Progress Over the Years

During the ensuing years wheat breeding work and some of the individuals involved at the Agricultural Experiment Station became internationally known. Varieties were produced that were better able to stand the state's varying conditions and disease problems. Some of the genetic materials in these early wheats are still used in varieties nationwide. Many South Dakota wheats have their distant origins in Russia and Turkey.

Wheat breeding has advanced to the stage where researchers use sophisticated methods in the laboratory and special refrigerator-like climate control chambers in addition to growing and testing with field plots. They may even plant experimental plots in the Southwest or in Mexico to "gain" a season. As an example: a breeder can select

specific genes, the unit of inheritance, from among thousands of varieties of wheat or closely related plants and introduce these better genes affecting disease resistance, winterhardiness, straw strength and higher grain protein into varieties which are otherwise good. Plant breeding is a long-term business and for every advance there is a long list of things that didn't work—not failures, exactly, because the plant breeder benefits from learning about what won't work as well as from what will.

A lot of testing is needed in breeding work involving winterhardiness as breeders try to combine a "foreign" variety and a commonly used variety. Wheatgrass is being used to try to introduce a characteristic into common varieties that involves immunity from wheat streak mosaic, another costly disease.

These accomplishments still have not eliminated the risks of raising winter wheat. Today South Dakota growers may still suffer annual losses amounting to thousands of dollars because of unpredictable adverse winter conditions. Plant selection programs have shown that the capacity of small grains to "winterize" involves heritable factors. Internationally recognized research now going on at SDSU involves an analysis of genetic lines and the basic weaknesses of plant cells under freezing stress. Winterhardiness problems actually may be caused by too much "heat" at the wrong stage in the growing season.

Higher Protein Content

One of the newest aspects of winter wheat breeding research involves a source that produces higher protein along with rust resistance in several selections from Agricultural Experiment Station plots. The new high protein and rust resistant winter wheat at four South Dakota test locations averaged 15.1% (and as high as 20%) flour protein and has the quality of a good spring wheat. Winter wheat protein content normally is about 13% in South Dakota. It does have certain agronomic deficiencies which are being improved by backcrossing, one of the "tools" used by plant breeders.

Stubble mulch has been used in stretching the winter wheat belt northward. Some growers and Agricultural Experiment Station research have shown that stubble can protect winter wheat in the traditional spring wheat areas. Winter wheat survived very well in northeastern South Dakota when planted in stubble mulch where there was adequate moisture. Yields compared with those of spring wheat. The idea is to use a sweep that cuts weed roots and loosens the soil while leaving most of the stubble (usually flax or barley) standing. Seeding is with a press-drill and in experimental plots survival rates ranged from 48% to 81% to no winterkill at all in some instances. In corresponding plots on fall plowed land, survival rates were from 1% to 18%. Survival of less than about 40% is considered unsatisfactory for a crop. Both early fall growing wheat and the stubble reduce water and wind erosion of soil during winter and spring. Stubble "catches" snow and protects the wheat and reduces the velocity of cold winter winds.□

Objective No. 3—Increase Production Efficiency of the Beef Cow

AGRICULTURE is South Dakota's major industry and the beef cow is "king of the hill." Preliminary estimates indicate that 1972 was an all-time record breaker with receipts from marketings of livestock and livestock products going over the $1 billion mark for the first time. The 4,496,000 head of all cattle and calves on farms and ranches on January 1, 1973 with a value of $1,236,400,000 was greater than for any previous year. South Dakota ranks sixth in the nation in total number of beef cows.

Increasing production efficiency of the beef cow in South Dakota is a goal going back nearly a century. Modern research—from computerized mating to automated feeding devices—is progressing not only in making the beef cow a more efficient converter of feed to meat but aims at making most efficient use of the range or feedlot involved in producing beef.

If you have the idea that South Dakota's early cattle industry began with the east-to-west migration of a pioneer with only a smattering of knowledge about cattle, you're wrong, according to at least one historian. You're also wrong if you think the early industry consisted only of herds of Texas longhorns driven by boisterous bands of trigger-happy, drunken cowboys, according to this same historian, Paul Edwards of Graceland College, who has made intensive studies of the cattle industry, and its people, both in the U. S. and abroad.

Seek Grass Early

South Dakota in the late 1800's was the end of the trail – actually about the only remaining place to go—for herds of cattle moving in from the Southwest and Northwest seeking "special" grass for fattening. Thus it was a west-to-east type of movement. Dr. Edwards in a recent speech also pointed out that such pioneer entry into South Dakota was "late" and many of the people involved were likely to be experienced cattlemen with feeder herds—"die hards" who came into the last place available for the "special" grass. Texas wasn't the only "source" for South Dakota's cattle industry, Edwards contends, be-

cause many herds were foreign owned. For example, he said at least 43 British companies plus others from France and Holland were active in development of South Dakota's early cattle industry. Many of these cattle might be classed as "experimental," using imported breeds.

Edwards described the early South Dakota cowboy, who often found himself a "hired hand on a horse" especially during haying season, as generally a good, responsible person often remaining with his company for extended periods of employment. He described the early South Dakota cattle business and its associated functioning – from barbed wire to vigilantes – as one of the most peaceful for western settling periods. And of the people, he said "if some were not gentlemen, at least they were tamed."

New land for expanding operations is now limited, so the modern livestock producer has to turn to management and research to get the most out of what he has in both land and animals.

Pace Quicker Now

The modern South Dakota cattle producer probably uses a pickup truck or motorbike (and in a few years possibly satellites) to accomplish tasks his grandfather had to do by spending hours in the saddle. That progress is of the sort noted in development of new equipment. The modern producer also may spend more time studying a computer printout than his grandfather did in heating a branding iron. That's just an example of progress in SDSU animal science research in which a computer program called "Simumate" has been developed to aid the producer in planning a crossbreeding program that gives the best returns for his own particular operation and resources.

This computer simulation program is designed to aid the producer in choosing breeds and crossbreeding systems that take advantage of hybrid vigor (heterosis) and the combination of desirable traits from more than one breed of cattle. Companion research indicates that crossbred heifers seem to have less calving difficulty than straightbred heifers. The computer program has been adopted by 13 other universities—including one in Germany—and often finds its way into classrooms for instructional purposes.

Earlier Weaning

Another experiment indicates that calves can be weaned satisfactorily at 3½ months of age although total feed costs were increased. In this case these costs amounted to $47.18 for winter cost of creep feeding an early weaned calf and hay for the cow, compared with $42.16 per nursing cow and her calf over the same period.

What effects do rates of backgrounding growth have on subsequent feedlot (finishing) performance? In one experiment, 570-pound steers backgrounded at four different rates of per head daily gain ranging from 1.4 to 2.4 pounds performed similarly during the finishing period with average daily gains ranging from 3.29 to 3.15 pounds.

Nutrition must carry strong emphasis in SDSU research aimed at boosting production efficiency, either through what is fed, how it is fed, and in some cases when or where it is fed. Briefly some of these findings include:

Beef Research Briefs

Whole corn can be fed successfully, thus decreasing processing costs. No advantage for weight gain or feed efficiency was obtained from grinding or rolling corn, either dry or high moisture, when fed in high concentrate, finishing type rations.

Feeders can realize savings, lumber mills increased income, and society less pollution by incorporating sawdust in high concentrate livestock diets rather than burning it.

Lower costing urea proved to be equal to more expensive soybean meal as a protein source for finishing cattle after the initial adaptation period.

High moisture corn equals or exceeds dry corn in feed value per pound of dry matter, thus eliminating the necessity of drying grain fed to cattle. Considerations relative to storage become more important with high moisture corn.

Feedlot and carcass potential of bulls indicates considerable potential especially with the banning of certain hormone additives.

Supplementation of aureomycin-sulfamethazine has resulted in consistent gain improvement during the feedlot adaptation period.

Supplements with up to 4% urea may be used satisfactorily during the early stages of the feedlot period when low energy rations are fed.

The efficient productive beef cow is usually an animal which spends a minimum of its growing time and effort at fighting off effects of diseases, insect pests, and detrimental climatic conditions. (See also Objective 4 on improved pasture and range land, Objective 6 on management, Objective 12 on better marketable products, Objective 13 on crop and livestock pests, Objective 16 on livestock shelter, and Miscellaneous regarding animal diseases.)□

Objective 4—Increase Per Acre Yield of Pasture and Range Land

SEVEN years after the Agricultural Experiment Station was established, it published a 212-page bulletin (No. 40), "Native and Introduced Forage Plants of South Dakota," by scientists in the Departments of Chemistry and Botany. This 1894 publication, profusely illustrated and the largest up to that time, discussed South Dakota grasses (some of which were classed as weeds), their adapted areas, chemical analyses, and value as livestock feed. A smaller updated version of this bulletin was published in 1901.

Another publication in 1897, No. 51, "Forage Plants for South Dakota," indicated the value of grasses as well as noting a changing pattern which acknowledged the need even then of other types of forages. In this publication are these statements:

"Our native prairie grasses have, in nearly all cases, been the principal, and in many instances, the only food of our stock.

"In these localities [the "older and more thickly settled districts"] our native grasses, which have been the basis of nearly all of our success in the past, are fast disappearing and being replaced by inferior introduced grasses and worthless weeds.

"Where native grasses have failed because of overstocking, more intensive farming, introduction of weeds, the best solution . . . yet discovered is to provide forage crops of some kind to supplement the failing supply of pasture." One of the first reports on forage research is Bulletin No. 74, published in 1902, on "Drought Resistant Forage Experiments at Highmore Substation."

Although both alfalfa hay and wild hay are harvested throughout the state, only a few places of small acreage remain in South Dakota where the original prairie has been untouched by plow or grazing.

The South Dakota Crop and Livestock Reporting Service notes that for the 1960-1969 period the hay crop averaged 47% alfalfa, 44% wild hay, and 9% "other hay" (grain hay, millet, sudan, clover, timothy, brome, etc.). The same source reports that 1972 production of all hay —a record high—was 7,082,000 tons from 4,597,000 acres worth an estimated $131,017,000. Of this amount 1,780,000 tons were wild hay and 5,302,000 tons were tame hay (alfalfa and others). South Dakota ranked fifth in the nation in production of all hay. Hay accounts for 25% of the total value of all South Dakota crops, ranking only behind corn.

Numerous Research Approaches

The modern effort to increase per acre production covers numerous approaches, ranging from fertilizers, interseeding, insect control, even to "going back" and recovering some of the original prairie plants and making selections from them for high forage and seed production as well as digestibility. Another research aim is to provide warm and cool season grasses that in rotational pasture combinations can give a longer grazing season. It isn't all just increasing grass yield, disease and insect resistance, however. In emphasizing a switch from yield in the field to yield from the paunch, one grass breeder explains that if an animal can digest one grass variety better than another, there will be a yield gain factor right there.

Research is specifically looking for improved regrowth characteristics in smooth bromegrass. "Synthetic" varieties involving five of the best smooth bromegrasses selected over several years from a collection of thousands of plants were grown in experimental plots in summer 1973. The selection of these cool season cultivated grass varieties (cool season grasses grow in early spring and then become dormant during hot months) was based mainly on regrowth capacity to increase efficiency of summer rainfall. Seed production is another key factor high on the list of requirements for these experimental grasses which are incorporated into "synthetic" varieties for additional testing.

A test near Norbeck was made to determine the relationship of seed size to ease of establishment. Grass seed, being small and light, is often difficult to plant and when planted, seedlings may not have sufficient vigor to become established under stress conditions.

Selections are being made for seed retention in reed canarygrass and creeping foxtail. A crossing program of six parents in creeping foxtails indicates a high heritability for the seed retention factor.

Use of Fertilizers

Fertilizing grass offers one of the best means to increase carrying capacity of pastures and ranges. At Norbeck it has been found that 4 years after 240 pounds (or more) of nitrogen fertilizer application, the per acre production of hay was still more than 500 pounds an acre above non-fertilized plots or in plots with amounts of fertilizer less than 240 pounds an acre.

In western South Dakota preliminary research indicates that, depending on soil type, 60 to 120 pounds an acre of nitrogen is required to obtain maximum production on both native and introduced grasses. One study underway is to evaluate the influence of varying rates of fertilizer and manure on carrying capacity of crested wheatgrass.

Also in western South Dakota it has been noted in preliminary observations that at least 95% of Japanese chess (a problem weed) was controlled by the use of a herbicide.

When the herbicide was used in combination with nitrogen fertilizer, a significant increase in desirable forage was observed. However, use of fertilizer without the herbicide stimulated growth of Japanese chess more than that of desirable grasses.

More than 200 acres of western native rangeland have been interseeded with alfalfa and will be grazed in 1974 experiments.

Mulching Alfalfa

Alfalfa is getting a "going over" with several approaches. One involves using a straw mulch to lower soil temperatures and improve soil moisture to increase yields. Annual alfalfa yields went up as much as 17% in research using a straw mulch. Immediately after an alfalfa cutting much of the soil surface is exposed to direct sunlight but a mulch appears to reflect some of the sun's energy from the soil causing lower temperatures at alfalfa crown depth or at about an inch below the surface. In a continuation of these experiments, preliminary results indicate that most favorable crown temperatures may be quite different than those for the roots. Effects of straw mulch on alfalfa yields are also being evaluated at other locations where limited rainfall may magnify the relative increase in plant growth due to lower soil temperatures.

"Controlled" or "prescribed" burning to control encroachment of Black Hills ponderosa pine in foothills range areas is another research approach for improving rangeland. Essentially this carefully controlled "cool fire" burning destroys unwanted, moisture-robbing pine seedlings that crowd out useful range plants on thousands of acres of mostly privately-owned foothills land. Results from one early study, to determine effects of removing unwanted or encroaching pine, found that total herbage production on a *cleared* acreage of ponderosa pine was 1,825 pounds (oven-dry) an acre which was about 1,500 pounds more than from an adjacent area where pine was not removed. In this research it is emphasized that the burning is carefully *controlled* and *planned* to destroy seedlings and a few saplings but not to penetrate to damage the mineral soil or layers of decomposing material just above it. Controlled burning does not jump into tree crowns for the type of difficult-to-control, destructive "hot" wildfire.

Research to Reduce Bloat

Still another factor in the research to improve pastures and ranges is the search for alfalfas which can be grazed by livestock without the ever-present fear of bloat losses. The fear is costly in terms of actual losses when bloat does occur and the psychological factor which erects a barrier limiting the use of alfalfa pasturage. The research is complicated, progress is measured in small steps. One advance is the laboratory "stable foam test" that rates legume plants as possible bloat inducers. Meanwhile, three non-bloating legumes are being evaluated to give producers a choice if they shy away from planting alfalfa for grazing. Crownvetch, birdsfoot trefoil, and sainfoin are currently being evaluated for South Dakota as perennial non-bloating legumes that are resistant to alfalfa weevil and produce nutritious high quality forage. Each of these has certain advantages as well as disadvantages under South Dakota conditions.

Insect control enters into increased alfalfa and range production. Under Objective 13 on pest control there are reports about research with a certain type of bee which was imported into South Dakota several years ago to use its specialty of pollinating alfalfa, about controlling alfalfa weevil with chemical sprays or progress in aid from imported parasites of the weevil, and about identification and distribution of range-damaging insects and mites.□

Objective No. 5—Learn to Use Irrigation Water Efficiently and Effectively

South Dakota's irrigation in 1971 was on 158,000 acres, the highest on record, and reflected a general trend upward, according to estimates by the Crop Reporting Service. Value of corn, grain sorghum, soybeans, wheat, oats, barley, potatoes and hay grown under irrigation was estimated at $8.8 million.

Alfalfa hay is one of South Dakota's most important irrigated crops, in 1971 accounting for 61,000 of the harvested acres with Butte County alone accounting for 25,500 acres. Average production of irrigated alfalfa is 3 tons an acre with a range of 1.9 to 6 tons.

Corn for grain accounted for 48,900 acres of the irrigated total, producing 4,449,900 bushels followed by silage at 14,700 acres producing 169,050 tons.

"Many landowners and operators have obtained water rights in anticipation of installing an irrigation system but for various reasons do not actually irrigate," according to the Crop Reporting Service. "Equipment expense and water shortage are the primary limiting factors."

Some 1,300,000 acres of South Dakota land are potentially irrigable considering current economic conditions and technical know-how. More irrigation would increase South Dakota gross farm income, stabilize livestock feeding and other resulting businesses, plus increasing business volume in such related areas as sales of irrigation pipe and

supplies, fertilizers, pesticides, seed and others.

Early Irrigation

Since the first attempts at more intensive farming, going back to the late 1800's, irrigation has been considered as a means of obtaining water for dry sections of South Dakota farmland. One of the largest projects has been the proposed Oahe Irrigation Project which got off the ground in 1944 with Congressional approval of the Missouri River Basin Program which included large dam construction along several states. One of these included a dam near Pierre which created Lake Oahe. Congress in 1968 authorized the first of a two-stage Oahe development program intended to irrigate about 190,000 acres in east-central South Dakota. The second stage would add some 500,000 acres to this.

Both pros and cons have developed in the Oahe project as well as in irrigation development in other areas in which the source of water would be pumped from underground reservoirs.

SDSU irrigation research ranges from economic and social impact studies, to the highly technical problems concerned with drainage, equipment and feasibility. The research is aimed at providing answers and knowledge about the technical aspects of irrigation while decisions are made by government or the individual.

Getting rid of excess irrigation water or controlling high water tables (drainage) is as important as moving in the water in the first place. Thus, drainage becomes an important aspect of irrigation feasibility. SDSU has been researching drainage problems for several years.

"Bi-level" Drainage

One approach is field and laboratory investigations for "bi-level" drainage, a method, if successful, that might reduce costs. Drain line depths and spacings are generally greater for irrigated lands in arid and semi-arid areas than or land in humid regions. (For example, average Oahe Unit drain line depths are figured to be 9 feet deep, spaced 790 feet apart). The investigation involves alternating the deeper drains (which require costlier installation procedures using a trench) with a shallower system, which combines new technology and less costly "plow-in" flexible drain tubing to a 6-foot depth.

Quality of drainage water remained constant during the first 3 years of a several-year research project on salt and water balance from a special 5-acre instrumented experimental plot that is irrigated and drained. One of the objectives is ability to predict drainage water quality by soil analysis and drain line evaluations.

Subsurface drain lines must have "envelopes" or filters around them to keep soil sediment out of the lines. Gravel is the usual envelope material, however, in some areas gravel is an expensive item. SDSU research has determined that envelopes of 3-inch all-gravel, 6-inch all-gravel, a combination of cheaper glass fiber and gravel, have all operated successfully in an Oahe Unit soil for a 5-year experimental period.

Multi-field Irrigation Systems

Nine South Dakota irrigators are cooperating with SDSU researchers in a study of multi-field irrigation systems—those in which center pivot irrigation machines are moved from field to field. Preliminary observations show that several cooperators are successfully irrigating alfalfa in May and June and moving to corn in July and August with the same machine. The program, where applicable, requires very little extra labor and offers a possible additional profit margin. A field experiment, to simulate multiple field irrigation, was established in 1973 using corn, alfalfa and oats to develop techniques for economic evaluation of other South Dakota cropping and soil systems.

Another project in progress is to obtain some of the basic knowledge whereby temperatures of growing plants (plant canopies) can be related to water use or loss, thereby making a step forward in determining just when a crop needs irrigation water or rainfall. The idea is that thermal (heat) properties of crops sensed remotely by aircraft or satellite could be used for predictions on a field basis over a wide area. Preliminary work indicates that canopy temperatures can be used to evaluate water losses and moisture stress of actively growing crops. The timing factor was further emphasized in supplementary research which found that even a moderate moisture shortage of only a few days during the critical heading stage of oats reduced grain yields by more than 40%.

Under Objective 13 on control of pests, are discussed a method of increasing soil moisture by weed control and what research is doing regarding insect control in *advance* of establishing irrigation areas.□

Objective No. 6—Learn How to Raise the Level of Managerial Skill on Farms and Ranches

MANAGEMENT is one of the "varibles" to be considered in agricultural production. There is not much, at least yet, we can do about changing rainfall, climate, sunshine and other such phenomena. The factor in management that requires expansion of land is also somewhat limited. But good, bad, or indifferent management can mean the difference between success and failure for an individual as well as better well-being for the entire state.

Agricultural Experiment Station studies of farmers and ranchers with nearly identical resources in-

dicate that management can mean the difference or variation in farm or ranch income of as much as $2,000 to $6,000 annually.

Experience and studies indicate that improved farm and ranch management can be learned and taught. Based on Agricultural Experiment Station studies the Cooperative Extension Service, for example, has set up an annual course conducted throughout the state called "Ten Steps in Planning Your Farm or Ranch Business," which has enrolled thousands of farmers and ranchers. A survey after 5 years of this educational effort, indicated that 70% of the enrollees, based on their own estimates of available resources and application of changes, had averaged annual net income increases of $2,000.

Computers Help Research

Meanwhile, research continues to seek other ways in which improved management can contribute to more dollar return. Computers are used extensively to make analyses of typical or model enterprises. Management can be said to be an arrangement to try different systems, a change in the way of doing things. It would take a lifetime by trial and error on a farm or ranch but a computer can "try" all methods in a few hours or less.

One of these studies involved a 400-acre model farm in southeast South Dakota which could be "tailored" to other size and types of farms. This study indicated the highest income plan for a beef enterprise was a 112-cow herd with enough feeders purchased to use all feed grains produced. According to this model, if feeders were not purchased, soybeans could be produced as a cash crop to replace feed grain acreage not needed to feed out calves produced on the farm from a 120-cow herd.

Another computer analysis revealed a cost-per-cow spread of $44 for six different feed combinations. Total annual costs including labor, at the time of the investigation, ranged from a high of $152 to a low of $108 per cow, current total charges may be $200 to $150 depending upon the type of feeding program—which, of course, is based largely on a total, farm-wide view of management tied in with a thorough knowledge and application of available resources. The highest cost ration was based on alfalfa hay, native pasture and tame grass pasture and the lowest cost ration included corn glomerate, alfalfa hay, native pasture, sorghum-sudan pasture and cornstalks. A 90% calf crop and 450-pound steers were factors assumed in the analysis.

Publications on Farm Planning

A series of publications is available on improving farm and ranch management in South Dakota as a result of research to show the most profitable combination of farm enterprises at various combinations of crop and livestock prices on different size model farms. These free publications show "Optimum Farm Plans" for eight study areas involving 26 east-central counties in South Dakota.

Other types of computer programs are being used in experiments in beef cattle research but investigators warn that successful farmers and ranchers will still have to be out "punching" cows frequently and not just inside punching computer buttons for a long time to come. ("Simumate" is another computerized system developed by the Agricultural Experiment Station to aid in planning crossbreeding programs and is discussed under Objective No. 3 on boosting beef cow efficiency.)

A computer program for making an economic analysis of grassland systems for beef production has been developed. This has been done as part of the pasture research project on developing an efficient system of land use for production of beef cattle. This computer program is "loaded" in the computer and can be operated from remote terminals such as are now being evaluated by the Cooperative Extension Service at the Watertown county Extension agent's office and the Agricultural Research and Extension Center at Rapid City.

More Forage Needed

Development of pasture systems to produce more forage is a major need in South Dakota if the livestock industry is to continue expansion and remain profitable. Beef cow numbers in the state increased by 38% during the past decade resulting in considerable overstocking and poor condition native grassland and tame pasture. An experiment still underway which provides a source of considerable management know-how involves determining the most efficient system of land use for production of beef cattle. It is also described as sustained land use or pasture series use. The use of forage species when they are most productive and palatable in "series" pastures is one of the keys for obtaining quality forage from early spring to fall. Preliminary results indicate the full-season tame grass pasture series permitted highest stocking rate; the native series the lowest, and short-season tame as intermediate. The full-season pasture system showed a 7-pound weaning weight advantage over the native treatment. Proper selection of forage species for use during specific grazing periods apparently is the key to improving efficiency of beef production on pasture.

"The man who will pocket the profits is the cow-calf operator who can produce a calf weighing at least 450 pounds every 12 months from all of his cows for less than $100 each (out-of-pocket costs)," a SDSU animal nutritionist recently said. He added that "while that seems an impossible goal, it can be done by hard working cow-calf men who know nutrition, breeding and health management of their herds plus factors dealing with economical use of crops, pastures or drylots." Management by the producer, research to provide him new knowledge are keys to improved cow herd feeding.

Statewide Variety Tests

Variety testing is another SDSU research contribution to management. As many as 13 sites in different cropping areas of the state may contain as many as 95 varieties of corn, sorghum, and small grain including some of the newest varieties development by seed companies. Here a farmer—and the researcher—can see for himself and compare varieties.

Elsewhere such tests include "new" or specialty crops such as crambe, mustard, lentils and others which a sharp manager with the know-how can make a decision on trying something new. These tests also reveal some of the pitfalls he must avoid for success. Sunflowers, for example, are moving out of the "new" crop category with acreage approaching the 100,000-mark in South Dakota. Acreage has increased more than sevenfold in the past 3 years as requirements for sunflower seed oil goes up. Average South Dakota production in 1972 was 1,130 pounds an acre. Birds and insect pests confront the commercial sunflower grower and research on these problems are part of these tests.

The benefits of proper management also evolves from knowledge research makes available about crop diseases and insect pests. This type of research not only attempts to establish preventative measures to constantly changing disease and insect problems as well as new methods or products for controls, but it also helps to establish "early warning" systems to decrease crop damage. (See also Objective 13 on crop diseases and pests.)

Soils Research from Satellites

Management—for individual as well as for governmental uses—also includes a knowledge of soils. Detailed maps resulting from years of soil surveying and study are available for nine South Dakota counties and 24 others are in various stages of readiness for publication in this cooperative Soil Conservation Service-Agricultural Experiment Station effort. Use of these maps often helps in the planning stage of raising managerial skills. An entirely new phase of developing knowledge about land evaluation, land use decisions, land values and other factors is being developed by SDSU researchers who use imagery obtained from the ERTS satellite orbiting at 550 miles.

A new nitrate-nitrogen test that will measure available nitrogen in the soil profile has been developed by Agricultural Experiment Station research. The management idea here is more profitable use of high cost, hard-to-obtain nitrogen fertilizer. The relatively simple management procedure of obtaining soil samples for analyses at SDSU soils lab provide the producer with information on more precise nitrogen application—not too much that would waste effort and money or not too little that would cost him yield and profit. It has been found that adequate fertility causes the plants to make more efficient use of the moisture present. Researchers estimate that proper nitrogen use would provide a potential profit of $21 million annually to farmers of South Dakota. Application of excessive amounts of nitrogen fertilizer doesn't increase net profits. Excess nitrogen increases the cost of production and when lost from the root zone of the plants through leaching or eroded from the surface may become a pollution hazard.

Fertilizer of any kind pays only when the added material supplies a need for the growing crop. This is why soil tests must be calibrated with field experiments using each element in which the grower is concerned.

Controlled Burning

A project in western South Dakota has successfully demonstrated that controlled burning is not only possible but a necessary management practice in improving areas in which there is encroachment of low quality ponderosa pine into grasslands surrounding the Black Hills.

Another factor of the many involved in management decisions results from research by agricultural engineers to develop a three-point hitch force dynamometer (or measuring) accessory. The engineers applied livestock manure to experimental plots at rates ranging from zero to nearly 112 tons an acre. They found no significant differences in forces required to plow, disk or cultivate due to the different application rates and the penetration resistance of the soil (to the various implements) was not greatly influenced. A further implication is that manure disposal on fields actually improved "soil-metal scouring" characteristics, meaning less abrasive deterioration of the implements.

Weather Research

And what about the weather? One aspect of agricultural engineering research can more or less be said "to learn to live with weather and actually put it to use." This is being done in South Dakota and regional research to refine a system of "Growing Degree Days for Corn." A publication shows six ways of computing Growing Degree Days and will allow hybrid corn breeders and farmers to better rate hybrids and varieties for different climate areas in the state. It incorporates heat input (from the sun) and allows the farmer to pick better seed for his climatic conditions and in case of late planting to pick a low heat unit crop for these conditions.

South Dakotans are no strangers to winds and windy weather and the more we know about them the better we can incorporate other management factors. Agricultural engineers are studying wind variations and methods of averaging across the state to help the farmer get better values of cooling effect of winter weather on man and animals, better design of animal shelters, better estimate of wind pressure on buildings and dynamic loads due to gusts, better value of evaporation and evaportranspiration in water use of crops.□

Objective 7—Provide Data and Information about Government and Institutions in a Useable Form for Decision Making

Local, county, regional, state, federal and—increasingly so—world governmental activities as necessities of an organized society are becoming more complicated, more diverse, and more difficult to comprehend. Add to this school, church, health and social institutions and you have a formidable array which many of us must deal with every day.

This objective, which by its very nature is characteristically open-ended, aims at providing data and information in condensed useable form to help create an increased level of understanding by citizens so they can more wisely choose alternatives or make decisions. Involved are costs of services wanted, expected consequences of possible shifts in procedures ranging from your local school district to the condition of crops in Russia or South America.

One current research effort is to update and include new material on a comprehensive publication developed several years ago: "Citizen's Handbook—South Dakota Governmental Finance and Employment."

A Black Hills study is underway to analyze business and management characteristics of private camp grounds, which are being developed at an increasing rate to accommodate the current American desire for travel, "back to nature," and lower cost vacations.

Industry Impact Study

Another study on the impact of a new industry, using a specific firm in an eastern South Dakota city, mainly was of value because it helped develop improved procedures for guidance and conducting further research. A positive impact for the new business was found for retail sales, total income, per capita income, mill levies, employment and unemployment. Impact on bank debits was inconclusive.

County governments are of interest to South Dakotans because they are "close to home" and that in numerous instances are a somewhat controversial step on the ladder of government.

Economists making the county government analysis used an array of statistical information for all 64 organized counties in South Dakota based on per capita costs of 11 county government functions and nine independent variables such as assessed valuation, income, population and its change, rural employment, child and age dependency. The analysis revealed that primary determinants explaining the variation in per capita costs of county government were per capita assessed valuation, percent change in population from 1960 to 1970, and aged dependency ratio. Population per square mile was important but lacked overall signficance to be a primary determinant.

Who Will Be in Control?

"Who will control U. S. agriculture?" needs to be answered before effects of changes in agriculture on community services can be evaluated, claims one SDSU economist. His study indicates that while farms and ranches will continue to grow in size there is little evidence to support the view that large-scale farms (corporate or otherwise) operated by hired men are likely to control field crop production and ranching. Large landowners have always found it more profitable to sell or lease their land to independent family farmers than to attempt to farm it with hired men. He believes that new technology has not and will not change this situation.

Because the purchase of land for either large-scale farming or for leasing is not very attractive, the economist believes that increased concentration of land ownership will come very slowly. Because large landlords are more conspicuous than small landlords they are likely to find it to their advantage to give their tenants more of the freedom now enjoyed by owner-operators. Their freedom to improve buildings and land will be increased because the use of cash rents will increase their security of tenure.□

Objective No. 8—Learn How to Maintain a Healthful and Pleasant Environment for South Dakotans

ENVIRONMENT, ecology, waste management, pollution control, effects of pesticides and preservation of natural resources are items built into one or more research projects in the 14 departments of the Agricultural Experiment Station.

Some environment studies have been a part of research at the Agricultural Experiment Station since the beginning back in the 1880's when projects emphasized tree planting (windbreak and orchards), control of topsoil, and others directly related to what is being done now. The field is so encompassing and so complicated by the interaction of so many factors that one solution can bring up additional problems. For example, if fertilizer use is completely barred because of possible soil and water pollution, we have to come up with something else that will enable farmers and ranchers to produce enough food for a growing population. If pesticides or weedicides are banned without suitable replacements, many crop growers would be forced out of business.

Rapidity and selectivity are two requirements in detection of farm animal waste pollution of water. In one project, which emphasized "indicator" bacteria from water samples, the Agricultural Experiment Station has developed a rapid laboratory method to determine amounts of *Streptococcus bovis*, a fecal streptococcus organism found only in ruminant wastes. Thus, it is possible to determine if a stream or body of water is contaminated and the source more easily determined.

Disease-causing organisms which present the greatest hazards for both man and farm animals are *Salmonella* spp. One research project which improved methods for detection of salmonella in low numbers in lakes and rivers, has been even further improved for quantitation (determining numbers) as well. It provides for a routine, visual detection of salmonellae from water samples.

The Insect Battle

Much of the work to maintain a healthful and pleasing environment for South Dakota is in constantly improving control of crop diseases and pests. Needed are better chemicals, resistant varieties, timing of application, and use of enemies or parasites of crop destroying insects. One project in western South Dakota is using different spraying times and chemicals to determine if early sprays for alfalfa weevil control will increase parasitism by a natural enemy of the weevil. Lowest weevil larvae numbers and highest percent parasitism at harvest resulted with mid-April and 10-day later application of insecticides. Timing of application is illustrated in this research because of danger to alfalfa pollinating insects, especially bees.

Alternatives of upstream storage facilities for water release during critical periods or requirements that waste discharge be treated at the source are conclusions reached in a study of control of water quality of the Big Sioux River. Indications were that to determine major sources of pollution research should concentrate at firm or plant level rather than at the aggregate level.

Whey, a cheese-making byproduct often bearing a "pollution" tag, is high on the list of SDSU research to find new uses for such substances. Uses of whey and other products are discussed in more detail under Objective No. 12 (new products) and No. 15 (reducing feed costs).

Trees in the Environment

Trees and tree planting and what they mean to a healthy, enjoyable environment as well as protection continue to be sources of Agricultural Experiment Station research. Being investigated in one phase of this research are seeds and seedlings from different sources in the Northern Great Plains region. South Dakota sources of hackberry and American elm generally appear better than those from North Dakota, Nebraska, Colorado and Kansas. Nebraska sources of green ash appear better than those from South Dakota and other states. Experimental crossing with Siberian elm and slippery elm, after nine growing seasons, has shown that the hybrids have averaged more than 3 feet in height growth than seedlings of Siberian elm, the fastest growing comparative progeny of the parent species. These hybrids may serve as fast-growing trees in windbreak plantings for early protection and overall height.

Height growth in windbreak plantings with closer between-row plantings generally appears to be better for ponderosa pine, green ash and hackberry although Siberian elm does not necessarily follow this pattern in research at Brookings, Highmore, and in Harding County. Blizzards and snow breakage have hampered these experiments. Narrow spacing aids in weed control because of shading. Overwinter storage of coniferous stock was found best at 1 degree C. (33.8 degrees F.) for ponderosa pine sealed in plastic bags and for Eastern redcedar sealed in plastic with moist moss.

The Amazon lily may now be flowered by commercial growers on a year around program as a result of Agricultural Experiment Station research which found that bulb temperature is the primary factor influencing flower initiation in this attractive plant. The studies have determined the minimum temperature for flower initiation, time and

temperature interrelationships regarding vegetative growth and flowering, and a year around flower-production sequence. A mechanical means for controlling soil temperature has been developed so time of flowering may be regulated.

Mercury in Environment

Several experiments are in preliminary stages regarding mercury in our environment. Laying hens were fed mercury at levels up to 20 parts per million (p.p.m.) inorganic mercury and 10 p.p.m. of methyl mercury (an organic form produced by some microorganisms). In the first egg laying cycle, egg production was lowered by the highest level of methyl mercury. Evidence was found of depressed egg quality and hatchability with hens fed 5 p.p.m. or more of methyl mercury. These eggs usually contained more than 7 p.p.m. mercury while eggs from hens fed up to 20 p.p.m. inorganic mercury contained less than 2 p.p.m. Longer-term accumulative effects of mercury treatments on eggs is being determined in continuing research. Pheasants in only a few instances exceeded a value of 0.05 p.p.m. in liver, kidney or muscle while fish-eating cormorants averaged 0.64 p.p.m. in the whole body. Importance of research is to gain insights on potential hazards of mercury in the food chain of animals and man and possibly how to avoid them. Future research will deal with interrelationships of mercury with other elements.

Can nitrate levels in large plants be evaluated on the basis of actual determinations of the content of plant parts such as internodes, sheaths, leaves, ears, and tassels? Since nitrates can be a killer when livestock are fed drought-stressed corn, for instance, research is underway to determine more rapid, specific methods of detecting dangerous amounts.

Clean Air

South Dakota is proud of its wide open spaces and clean air. Relatively speaking, the state is fortunate in this situation. The main question is "can we maintain our status and what should be done?" Evidence of smog-like air polution (ozone) has been detected in several areas of the state through a low-cost, local-cooperator system of growing special tobacco varieties which are highly susceptible — or "indicators" — to ozone. Although it was first believed that the source of most ozone was from areas outside the state, 3 years research indicates that highly populated regions of South Dakota have ozone levels higher than rural regions and that South Dakotans do contribute to the air pollution affecting plant life in the state.

Some slight air pollution damage to alfalfa has been found in the eastern part of the state but the area is limited and it is believed not intense enough to cause economic damage. Intensive air pollution of this type, in California for example, has caused millions of dollars in crop loss. Research elsewhere delves into seeking crop plants with resistance to this type of air pollution. So far in South Dakota it is more "monitoring" our relatively clean air to establish a benchmark so that in case excessive air pollution is noted in the future the sources may be more easily spotted.

New findings for South Dakota air pollution include: Uniform growing conditions usually were not essential, but extremely dry soil conditions did reduce ozone injury to Bel-W-3, the tobacco "indicator" plants. Weekly sprays of a chemical, also effectively used to combat certain fungus diseases of plants, prevented ozone injury from developing on Bel-W-3 tobacco in the greenhouse at Brookings. Cotton plants showed no evidence of injury from sulphur dioxide, but leaf injury symptoms like those caused by 2,4-D were found on cotton plants at many locations in the state during the past 3 years. Thus, 2,4-D must be considered one of the pollutants recognized in South Dakota's clean air.

Early Prairie Plants

A healthful and pleasant environment for many people concerns preserving a heritage of prairies untouched by the plow, specific natural or the older man-made landmarks, and a "source" of some of the early prairie plants. Many of these prairie plants are becoming candidates for the 1972 Soil Conservation Service listing which included 144 endangered plant species in South Dakota. Seed collection or digging up a plant to preserve it elsewhere are methods too often unsuccessful in attempts to propagate prairie plants. A new approach is being tried to improve the odds by using tissue culture techniques. This method, if successful, might enable researchers to obtain up a dozen plantlets from a single leaf. Prairie plants are receptive to this method but research is continuing to seek ways by which this technique may be improved. Preservation of native or endangered species is not only important from an aesthetic standpoint, but the fact they have existed under South Dakota conditions for perhaps thousands of years may provide the plant breeder with sources of material to incorporate into some of our "newer" crop plants.

Livestock Wastes

Disposal of livestock wastes has high priority in Agricultural Experiment Station research. The Departments of Agricultural Engineering and Civil Engineering cooperating with the Water Resources Institute have obtained considerable information to help producers in this phase of agricultural production. Analyses indicate that snowmelt runoff, which contributed nearly 30% of the runoff, is the prime source of polluting water from livestock feedlots. About half of the rainfall runoff events occurred when the surrounding area did not produce runoff. Therefore, with the minimum practice of diverting foreign runoff around the feedlot and detention of runoff from snowmelt and light rainfall events, a pollution potential reduction in excess of 50% would be realized, according to SDSU findings. Because typically 95% of the total generated wastes are removed by cleaning and decomposition having only 5% as a feedlot pollution hazard, the researchers could account for a measured 2% solid removal from the lot by runoff when the minimum storage and diversion was built. An instrumented feedlot is being used to determine the effect of rations on waste with particular emphasis on salt and potassium content on the composition and quantity.□

Objective No. 9—Provide Information for Improving the Management Talent and Skills of Homemakers

It takes a lot more than green fields, producing insect- and disease-free food crops and healthy livestock consuming a low cost ration to make agriculture the major South Dakota industry involving virtually every resident.

There's the helpmate—the homemaker, urban or rural, who puts it all together: the family and home. One of the most successful of managers with skills as a part of life was the pioneer South Dakota homemaker. Gadgetry, new inventions and progress (if that's the word), still putting it all together classes today's homemaker in the role of a modern pioneer. SDSU research of interest to homemakers may range from factors of manufacturing to actual use in the home.

"Convenience" foods are a major item in our lives and economy but some organisms in mass-produced precooked, frozen convenience foods may be harmful. Much of the problem arises through improper or poor storage and harmful staphylococcal organisms remain a potential danger even after the foods are heated for eating. SDSU research has developed a rapid, specific and sensitive method that reduces from 7 days to only a few hours the time needed to detect these possibly toxic organisms. Continued research aims at determining best manufacturing and storage conditions for convenience foods plus filling a need for a quantitative method of detecting these organisms. A routine assay method which would ultimately be automated is also being studied. Another approach in spot checking production line samples is being investigated by using radioactive iodine which should be about 10,000 times as sensitive for detection of toxins.

Laundry Problems

A homemaker can become as mad as the proverbial hornet if she spends the day washing clothes only to come up with off-white whites and other difficulties. Much of the problem is concerned with hard water in the Upper Midwest. In cooperative research to brighten the wash as well as the day, South Dakota and Minnesota homemakers have served as "at-home" researchers, washing special swatches of fabrics along with the family laundry. These swatches then went to the research labs for study. Data is being sought from which helpful recommendations can be made to cover the wide range of laundering methods, equipment, and different water problems.

Another research project is a study of the performance of polyester/cotton sheetings. The "wear and tear" of polyester/cotton pillow cases was furnished by SDSU coeds who put the fabrics into actual use in dormitories. The textiles laboratory laundered these pillow cases and used special equipment for analyses to get some answers for the consumer who is concerned with initial cost versus wear-life. It has been found that polyester/cotton pillow cases maintained strength for the specified period and scope of this research. The cases were not "worn to destruction" by 45 launderings so they apparently have a much longer wear period.

Evaluate Draperies

Draperies usually are a major expense item and in these days of saving fuel the insulation qualities are also of importance. Textile researchers are evaluating self-lined drapery fabrics and the face fabric-lining combinations to help the homemaker in selecting draperies. The research involves factors of color retention, humidity, tensile strength, and thermal insulation.

All of the data are not complete but another research project of interest to the homemaker is a study of lamb meat—its chemical composition, nutritional value, palatability and consumer acceptance. Ultimate objective is to help the homemaker decide if serving lamb meat at meals fits in with her budget and nutritional needs as well as determining cuts of lamb most liked by her family.

What happens when sodium hypochlorite bleach is used on durable press fabrics? So far cotton and cotton/polyester blended shirting fabrics, with and without durable press finish, have been laundered without bleach at two different temperatures. This provides a "base" for continuing study involving different chlorine concentrations and their effects on durable press.

Additionally the homemaker will be interested in SDSU research investigating new and different ways of preparing various foods—including wild game. These are more fully discussed under Objective No. 12 on new marketable products.□

Objective No. 10—Provide Knowledge Base for Developing the Recreational Potential in South Dakota

A WATER-RELATED paradox exists in South Dakota: season after season the farmer looks for more rain (or better distribution of it) but a multitude of reservoirs, lakes, streams and even farm ponds make fishing and other water sports a potential yet to be fully realized for recreation.

Additionally, South Dakota is known for its variety of wildlife and research is underway in several projects regarding this resource as well as preserving some species that are classed as "endangered."

Keeping water recreational facilities environmentally fit and productive as well as preserving our wildlife is a phase of research conducted to a large extent through the South Dakota Cooperative Wildlife Research Unit including these agencies: South Dakota Department of Game, Fish and Parks; South Dakota State University; U. S. Bureau of Sports Fisheries and Wildlife; and the Wildlife Management Institute. Others on the campus are also active in this type of research, ranging from agronomists to zoologists.

Management of farm ponds for fish production used ponds in Jackson and Pennington counties to obtain data. Preliminary information indicates that water quality was mainly determined by geochemical factors and a positive correlation was found between concentrations of nitrate nitrogen and numbers of blue-green algae. The worst pond in the study was characterized by high levels of dissolved plant nutrients, dominance of phytoplankton (a form of plant life), populations of blue-green algae and a relatively low standing crop of fish.

Above-Average Fish Crops

Standing crops of fish in the farm ponds investigated were generally above national averages for unfertilized ponds, exceeding 500 pounds per acre in one pond. Factors favorable for standing crops of fish included number of species of fish present, alkalinity levels, numbers of zooplankters (an animal-type of microscopic organism) and numbers of phytoplankters (excluding blue-green algae).

Furthermore, the investigations indicate plans are needed for more complete use of this available fishery resource since the ponds received less fishing pressure than they probably can sustain due to their remoteness from population centers, low local population, and high number of ponds in the area.

More information is sought regarding importance of various types of wetlands to waterfowl production. Initial data has been gathered from 500 quarter-section plots covering major physiographic regions of South Dakota. Breeding-pair censuses have been made as well as recording ecological descriptions of all water-holding depressions such as wetland vegetation type, acreage, water level, shoreline length and adjacent land use. When fully compiled the data are expected to provide regional and statewide population estimates of the number of breeding ducks and densities of breeding pairs. The Water Resources Institute of South Dakota is a cosponsor of this research.

Pheasant Research

The ring-necked pheasant is an important source of hunting as well as an important recreational economic factor in the state. Some research on movement, behavior and activities of pheasants is conducted by attaching tiny radio transmitters to wild birds and then tracking them with special receivers. Some of the findings indicate that management areas of about 100 acres could attract and support pheasant cocks in an agricultural area. Areas managed for pheasants should have diverse cover types, especially during the breeding season.

Once the hunter has obtained his deer, pheasant, or in some cases even buffalo, the next stage is preserving and preparing it for eating. Food research by Home Economics Department personnel is aimed at helping in this, the ultimate phase of the hunt, by finding methods of preparing the game for the table (see also Objective No. 12 on developing products from new sources).

Bighorn sheep, which live in small numbers in the Black Hills area, are seldom seen. Agricultural Experiment Station zoologists are attempting to aid these rare animals by reducing the incidence of lungworm, which have been found in all animals observed. Attempts have been made—so far unsuccessful—to capture some of the sheep for experimental pen studies to test acceptance of various formulations of chemicals (anthelmintics) in feed pellets with a view toward feasibility of use in the wild. Part of the continuing studies will involve source of the lungworm and its life cycle including the possibility of intra-uterine transfer to the fetus. The two species of lungworms which occur in the bighorn sheep (and also in mountain goats) of the Black Hills are limited to these two host animals. The lungworms will not develop in man, and apparently they cannot adapt to domestic livestock.

Cooperative research involving two or more organizations include these studies:

Prairie dog-black footed ferret relationships (the ferret is a rare animal and the study will also include foot habits of prairie dogs).

Deer and cattle forage relationships in the Black Hills.

A study of the striped skunk in eastern South Dakota.

Evaluation of the wild rice watershed development.

Effects of polychlorinated biphenyls (PCB's) and DDT on white pelicans.

A study of small mammals on a wetlands area in Brookings County.

Dissolved organic matter, seston and zooplankton and zooplankton cycles in Lake Poinsett.

Food selectivity of the black bullhead in Lake Poinsett.

Chemical survey of selected South Dakota lake sediments.

Primary production and algae of Lake Poinsett.

Food habits of brown trout in relation to daily (24-hour) drift organisms in the Yellow Bank River.

Creel census of Lake Sharp and tail waters.

Food, growth and production of walleye in a South Dakota pond.

A study of an aquatic insect ("water boatmen"), its ecology and contribution to the fishery forage base in Lake Poinsett.

Results of research in the early 1970's will bear fruit in 1974 with publication of an Agricultural Experiment Station bulletin on ecology of a forest covering a century of time. Basis for the study and publication are pictures taken by a photographer accompanying the 1874 Blacks Hills Expedition of General George A. Custer. The exact spots from which the early photographer took his views have been determined and "matching" photos taken in the 1970's to show development of the forest over a 100-year period. Although this publication, now in press, will feature a discussion of ecology in popular style, many historical facets of the expedition will also be included.□

Objective No. 11—Develop Spring Small Grain Varieties with Higher Yield Capacities

Spring small grain improvement in SDSU research includes wheat, barley, oats and flax, concentrating on problems dealing with adapting crops to the unique soil and climate in this state. Research may be in experimental plots and greenhouses in South Dakota or plantings may be made elsewhere (Mexico, for example) where a season can be "gained."

Various groups within the state have actively promoted the spring wheat program and the 1972 legislature appropriated $20,000 to start this project. Several factors must be considered in improving spring wheat: superior varieties themselves, better production practices (management) to include irrigation, commercial fertilizer and agricultural chemical use, and top quality. At least one new dwarf type spring wheat variety and a new high protein oat line are expected to be released within 5 years.

Latest research, which has produced about 52,000 first generation seeds from more than 3,000 individual crossed heads, seeks to incorporate genes for disease resistance, high quality milling and baking characteristics, better agronomic characters and to generally broaden the genetic base of the breeding program. More than 19,000 plot rows of segregated material were planted at Brookings, Redfield and Highmore. (Use of different sites aids in adaptation studies as well as preventing disasterous losses from unfavorable conditions at any one site).

More than 1,600 of the spring wheat lines have been evaluated in the greenhouse for resistance to diseases (see Objective 13 on crop diseases).

Short, stiff straw and high groat protein are main objectives in oat breeding research in which more than 180 different crosses were made. Some of the second generation crosses possess excellent crown rust resistance and several of the 9,000 selections being analyzed have over 19% protein. Research will continue to seek new genetic combinations for use in introducing rust resistance and high protein in future varieties. Chief is the name of a newly-released variety.

In flax breeding early generation testing is conducted cooperatively with Minnesota, North Dakota and Canada.

Several hundred introductions and varieties have been examined the past 2 years looking for a dwarf rye with good straw to aid in lodging problems especially in the northern part of the state. Two of the introductions are about 27 inches tall, compared to a normal height of about 48 inches for rye. Research is slated to develop a composite cross of adapted, winterhardy varieties with good yielding ability and shorter straw. Ten crosses of normal height rye were made and first generations of these were grown in 1973 experimental plots.

More Interest in Barley

South Dakota barley production, although concentrated in the northeastern part of the state, is grown in every county and is increasing in popularity. South Dakota ranked sixth nationally in barley production in 1972 on 576,000 acres yielding a total of 20,736,000 bushels with a farm value of $17,626,000. Estimates for 1973 go up to 637,000 acres with production at 21,658,000 bushels with a farm value of $39,850,000.

Included in latest research are attempts to develop a true feed barley with improved nutritional characteristics. The first advanced selections from the 2-row spring barley improvement program were increased in 1973 for inclusion in regional nurseries in 1974. The breeding research includes 2-row and 6-row standard, semi-dwarf, and uniculm spring types for dryland or irrigated cultivation and 6-row winter types for production on summer fallow in southwestern counties.□

Objective No. 12—Develop New and More Marketable Products from Agricultural Produce.

THROUGHOUT the SDSU Agricultural Experiment Station some research is almost continually aimed at developing new products from South Dakota agriculture as well as putting familiar products in new "packages."

Being sought may range from uses of wheat in new forms, use of a byproduct for human or animal nutrition, a new fruit . . . even how to prepare buffalo meat just in case you run across it in the supermarket or on a special hunt. Sometimes researchers have the product and look for new uses (wheat, for instance) or there's a use (protein supplements for livestock feed) for which the researcher seeks a new or altered product.

Several new food items have used a freeze-dried wheat product previously developed in foods and nutrition laboratories at SDSU. Freeze dried hard red spring wheat was used in several types of confections including brittle, almond bark and oven-baked caramel wheat. A commercial company is working on marketing feasibility and further bench testing of the new product to determine other possible uses.

Triticale, a rye-wheat cross, was used as a freeze-dried product and as either a whole grain flour or cracked whole grain. Noodles were made from whole-grain flours of triticale, durum, hard red spring wheat and hard red spring dwarf wheat varieties. Taste panel evaluations indicated flavor of triticale noodles was preferred. Triticale whole-grain flour was also used in several types of breads and a nutritious, highly palatable breakfast bar was made from cracked triticale.

Buffalo Meat Research

The National Buffalo Association is assisting in collecting bottom round cuts from buffalo in 10 places in the United States for new research on cooking methods and analyses of buffalo meat. Previous research has developed recipes for preparation of venison and pheasant as well as possible commercial use of freeze-dried and smoked pheasant.

Pea beans, the type used for baking and for pork-and-beans, have grown well in eastern South Dakota during the past 2 years and might turn into a "new" crop for the state, according to SDSU research. Growers can obtain yields of between 1,200 and 1,500 pounds an acre on dryland during an average growing season, the research shows. (One early grower had some 200 acres of pea beans which yielded more than 1,200 pounds an acre—and he sold them at 25 cents a pound). Pea beans are grown, harvested, and handled similar to soybeans. In other research on "new" or improved crops, a total of 65 hybrids developed from promising inbred tomato lines are being evaluated. Thirty-five different hybrid peppers are also being evaluated.

Research has found that keeping quality of onions differs with variety and storage conditions. Within a variety, storage life is directly related to the curing condition after harvest. Ideal conditions for curing, to maintain high keeping quality, as determined by SDSU research are ventilation, length of curing, depth of onions during curing, and temperature.

Research with Whey

South Dakota has reached major status as a cheese manufacturing state with current annual output of more than 50 million pounds. However, for each pound of cheese some 9 pounds of whey remain as a byproduct. This is enough to provide every man, woman and child in the state with 650 pounds of the pale, unpalatable liquid (although about half of it is now being used for various products). With this much whey, SDSU research is seeking various ways of making use of it. Some of them are:

Adding 2% dried whey, 1.4% lactose (the amount in 2% whey) or 7% lactose to haylage increased digestibilities of the haylage dry matter, energy and fiber constituents. Chemical constituent digestibilities were usually highest for 7% lactose haylage. Cows fed whey-treated haylage gained more weight than cows fed untreated haylage although similarities for both groups were noted for other factors such as milk yield and composition, rumen pH and volatile fatty acid values.

Liquid or dried whey protein concentrate from ultrafiltration is being used as an ingredient for *dulce de leche,* a sweetened, condensed caramelized milk product similar to a confection well-known in Latin America. Additional research aims at eliminating a problem of sugar crystals developing during storage.

Cheese-flavored spreads, with dried whey as one of the ingredients, with 5% to 10% milk fat content have been made in the research labs. Some spreads with only 3% fat still need formula modification to provide a firmer, less "weepy" body.

Other research uses ultrafiltration equipment to reduce bulk and make transport of whey to processing plants more economic. Attempts are being made to characterize the fats and functional properties, such as whippability of whey protein concentrate. A whey protein concentrate is being tried to supplement milk for young calves as a possibility to increase growth weights.

Coloring Egg Yolks

Egg yolk pigmentation research continues, currently using feed products with and without synthetic

pigmenters to ascertain their yolk color enhancement properties. Hens used in the study are depleted of xanthophylls, the yolk "coloring" substance. People in different parts of the country have preferences for different colors in breakfast egg yolks and manufacturers of food mixes generally seek standardized, intense coloring obtained by using very dark colored egg yolks.

Heavy-type turkeys sometimes have heart problems, which, of course, are of concern to the producer and consumer. SDSU research has determined that adding copper (as a sulfate) to higher protein diets at a level of 120 parts per million results in reduced incidence of aortic rupture in turkeys. In another phase of this research, using low protein diets, the added 120 p.p.m. levels of copper apparently also acted to reduce the growth depressing effect of "4-nitro" phenylarsonic acid used as a blackhead preventative. With or without the 4-nitro, copper use resulted in increased market weights of turkeys. Aortic ruptures were all low in this experiment, attributed partly to an effect of the low protein diets and lysine along with copper sulfate supplementation.

An early-day SDSU plant explorer and breeder, the late N. E. Hansen, made collections in the U. S. and abroad to improve hardiness in plants of the Northern Great Plains. His collections, starting in 1897, still serve a vital need for specific characteristics throughout the Middle West and beyond. The fruit germ plasm orchard originating from his work is maintained as a part of Agricultural Experiment Station work. Some of this involves locating and propagating from specimen plants in old experimental orchards in various parts of the state. Two of his Siberian Almond shrubs, after intensive searching, were found on the SDSU campus and have been propagated for preservation.□

Objective No. 13—Develop Low-cost, Effective Controls of Crop Diseases and Pests

Insects

Surveys from April through November generally give an idea of abandance and potential future spread of economically important insects with special stress given to those of corn, small grains, forage crops, rangeland and livestock. Special surveys determine spread of specific insects—alfalfa weevil, European corn borer, and aphids on wheat, as examples.

Attempts are being made to introduce parasites of alfalfa weevil to help in control of this costly crop insect. One difficulty, however, is adjusting alfalfa weevil spraying procedures so as not to also kill off the parasite. Early sprays are being used against alfalfa weevil to determine if this will increase parasitism by a tiny wasp-like insect, which apparently is the original "native" associated with the weevils in western South Dakota. Several other parasites have been "imported" (some from Europe via federal screening labs) and released in the state. Collected weevil larvae were to be reared through the adult stage during the 1973 season to determine if these other parasite species may have been able to get a foothold.

Another beneficial alfalfa insect—the alfalfa leafcutter bee—was successfully introduced into South Dakota several years ago from Utah. Researchers now are attempting to vary the time of adult emergence of the bee to see if pollination of the early bloom of first crop alfalfa or the late bloom of the third crops is feasible. This is being done by comparing overwinter nests kept at unheated building temperatures and nests maintained at higher or lower temperatures until about June 1st. Both of these types of nests have also been placed under 2 inches of dry sawdust to determine if the layer would trap an insect predator while permitting emergence of the adult bees. Use of the alfalfa leafcutter bee to increase alfalfa seed yields has been highly advantageous to South Dakota producers.

Some Insects Migrate

South Dakota doesn't produce all its insects. Some migrate or are blown in by winds. One example is the spring migration of aphids. Joint Agricultural Experiment Station and federal insect lab studies reveal that occurrence of the "low-level jet stream" from the Southern Great Plains is related to the aphid catch at Brookings.

Two groups of grain sorghum lines have been segregated in breeding research because of potential shown for resistance to greenbugs.

Insects and mites may potentially limit grass production in western South Dakota. Research plots for both low and high range conditions have been set up in Butte, Harding and Perkins Counties for the studies. Field samples have established several families of mites and insects as a major part of the grassland fauna. Some of the species found are new for the state and many are unknown to science and will be described as new species. Previous research in central-western South Dakota established the fact that vast numbers of grass sap-sucking mites and insects were a part of the ecosystem. Control of these sap-sucking animals over large areas of range would not be possible from a practical standpoint in addition to potentially upsetting the ecosystem to the extent that even more damage might occur.

A survey is to be made of blood-

sucking flies of livestock in the James River Valley near Redfield. The survey is to be completed in advance of major irrigation projects in the area which may have considerable effect on population dynamics of livestock pests that are aquatic or semiaquatic in their immature stages.

Good horn fly control through June (less than 25 flies per side) was obtained using a commercial insecticide in dust bags rigged at sites near water and salt for cattle. Actual amount of the insecticide needed was not obtained because wind blew some of the dust from the bags.

Wipe-on application of one out of three commercial products tested proved superior for face fly control on horses. The most effective material reduced infestation average from 10 flies per eye to 3½ flies per eye after 23 hours.

Major Corn Insects

Insecticide products from commercial companies are tested each year to determine potentials for use under South Dakota conditions. In 1973 tests 20 products from 10 companies were used for evaluation in corn rootworm larval control. In addition, similar or other materials are tested for adult rootworm control. Research also aims at detecting possible resistance of corn rootworm to currently used insecticides.

Research has shown that some corn rootworm control materials are also effective in control of European corn borer. Although corn borer infestations fluctuate in South Dakota, when they are up they cause considerable damage. Using insecticides in granular form which lodge in whorls and leaf sheaths of the corn plant, entomologists have recorded excellent control of the corn borer. Usually the granular-form insecticides are flown on. Some planting time treatments with systemic insecticides in corn rootworm control have also been proved effective in reducing populations of European corn borer. However, at the present time because of higher rates required (and higher costs) this form of corn borer control is not recommended for South Dakota.

Crop Diseases

Major stand losses in irrigated alfalfa near Redfield and Newell apparently result from phytophthora root rot, according to studies of foliar and root diseases of alfalfa. Such losses were especially evident in low-lying parts of fields suggesting the need for a more uniform leveling of the ground.

Research using 31 genotypes of smooth bromegrass with varying susceptibility to leaf disease indicated that, in general, disease infection increased with age of leaf as measured by position on the stem. Laboratory digestibility studies showed that the mean of all leaves was 23.09% diseased and digestibility level was 57.04%, which was about 18% less than normal for undiseased smooth brome. Further analyses indicated that 1% increases in disease and/or leaf age resulted in further decreases in digestibility.

Isolates of *Helminthosporium maydis* races 0 and T (Southern Corn Leaf Blight) and a "new" *Helminthosporium* sp. first found on corn in South Dakota in late 1972 were used in inoculation studies in greenhouse tests to determine blight reaction of inbred lines. This new strain produces symptoms on corn similar to races O and T and foliage damage is similar. The three strains were used in inoculation experimments under winter greenhouse conditions on a large number of South Dakota corn inbreds. Infection was abundant but variations in susceptibility resulted. The fungus varies morphologically from the other two strains and can infect corn in N-type cytoplasm (heretofore resistant).

Tree Diseases

Identification and control of diseases attacking the limited number of trees adapted to South Dakota's climate is essential to maintain a viable shelterbelt planting program. Part of the research is centered in searching for canker-free Siberian elms. Ten, 15-40-year old canker-free trees found in Brookings County (in addition to any found later) will be propagated by spring wood cuttings or root callous cuttings to compare canker susceptibility with normal seedling populations.

Inoculations of Siberian elms with canker causing organism in September 1972 produced large cankers and killed some trees during the spring of 1973. Tree wounds made by striking a rubber mallet against the trunks resulted in canker infections on 21 of 27 trees. Only four of 27 nonwounded control trees developed cankers.

Exposure of Siberian elms to 2,4-D may produce typical phenoxy herbicide injury symptoms for at least 2 years, Agricultural Experiment Station research shows. Siberian elms sprayed with six different concentrations of 2,4-D amine in June 1972 developed typical 2,4-D symptoms when they leafed out in 1973. Symptom severity varied directly with the herbicide concentration. Check, unsprayed trees, showed no indication of exposure to 2,4-D.

Eastern South Dakota counties experienced a severe outbreak of halo blight of oats at the mid- to late-boot stage. Several oats growing in experimental plots at SDSU demonstrated resistance. The organism which causes bacterial spot of bush cranberry was isolated after the disease was identified in a plant in Brookings.

The quick-dip technique for electron microscopy is being used to speed up diagnosis of virus diseases of cereal and forage crops. Wheat streak mosaic virus (WSMV), barley stripe mosaic virus (BSMV), brome mosaic virus (BMV) and maize dwarf mosaic virus (MDMV) were identified by this technique.

More Grass to Nematodes

It has recently been determined that plant feeding nematodes occupy a significant pathway of energy flow in a grassland ecosystem. High numbers of nematodes feeding on the roots of range grasses divert large amounts of energy that would otherwise be made available to livestock. Systemic nematicides applied to experimental plots in heavily grazed range in western South Dakota resulted in weight increases of above-ground harvestable herbage ranging from 28% to 59%. Populations of plant feeding nematodes

were reduced by as much as 87% to 91% in treated plots. Carefully controlled greenhouse experiments using soil cores from the same area resulted in even higher reductions of nematode populations and increased herbage clipping weights by 31%. Using nematode biomass data it is possible to estimate the intake for plant feeding nematode populations. Upon so doing researchers were surprised to learn that nematodes consume more range grass than cattle. The economic importance of nematodes in South Dakota is obvious and further research into methods of nematode control is anticipated.

Immunity from rust linked with high seed protein in a new South Dakota winter wheat germ plasm line are being backcrossed into commercial varieties by Agricultural Experiment Station plant breeders. Advanced high protein and rust immune selections are being tested. A genetic study has just been completed of protein level and rust reaction in the new South Dakota germ plasm line.

The federal insect laboratory and the Agricultural Experiment Station are cooperating in research which has produced progenies from wheat crosses involving resistance to barley yellow dwarf virus. These appear to have a good level of tolerance.

Most of 25 moldy livestock feed samples submitted for analyses by farmers or the feed industry carried varying amounts of potentially toxigenic molds. Only one sample tested positive for aflatoxin. The samples were submitted by persons suspecting possible ill effects to livestock consuming the feeds.

Control of foliage diseases could result in an annual input of more than $12 million to the economy of South Dakota, maintains a SDSU plant scientist. Several years research and application have resulted in a wheat rust prediction-spray advisory system now considered "operational." The do-it-yourself method involves three separate but inter-related calculations on predicting rust development, predicting yield loss, and estimating profits from spraying control chemicals. A special chart has been developed for use by the grower to make his calculations. Not only does the method offer a means of preventing losses in a crop, but it also protects the environment (and pocketbook) by indicating when spraying is unwarranted.

Weeds

Research on weed control the previous 2 years appeared to be providing some answers in 1973. As a result SDSU plant scientists are attempting to obtain permission from the Environmental Protection Administration for farmers to use additional chemicals for weed control. These additions include atrazine on native range to control annual weeds, mainly downy brome and Japanese brome, and for control of Canada thistle in corn. The experimental treatment not only controlled Canada thistle during the year of application but also provided good eradication the following year.

EPA approval is also sought for another chemical, trifluralin, which effectively controlled field bindweed when layered beneath the soil surface. Winter wheat, sorghum, corn and soybeans were planted over layers of trifluralin in 1973 with the objective of establishing a cropping system which could be used to control field bindweed if the addition is approved.

Choices Available

An addition is also sought for dicamba, which although not quite as effective for Canada thistle as split applications of atrazine, has the advantage of leaving no herbicide carryover to injure succeeding crops. Research continues on using metribuzin which appears to be an excellent control for Canada thistle.

Current studies on chemical fallow with winter wheat are designed to determine which chemicals effectively control weeds without causing injury to the succeeding crop. Weed control with chemicals in the fallow year was found to increase soil moisture by as much as 1 inch over that obtained with weed control by mechanical means.

Haphazard application of more and more herbicides, no matter how good they are, is not the answer to effective weed control, one SDSU plant scientist points out. If natural competition among plants is disrupted by controlling certain weeds while allowing others to increase, the "replacements" might turn out to be worse than the originals. This is one reason, the researcher maintains, that carefully planned control programs are necessary.

Two new weeds have been reported for South Dakota: fall panicum, a late season germinating annual grass becoming more evident in corn fields; and giant foxtail, a weed up to 5-feet tall and much more competitive and vigorous than ordinary foxtail.□

Objective No. 14—Adapt Grain Sorghum to the South Dakota Climate

An early maturing experimental line developed by the Agricultural Experiment Station, which was released in February 1973 as SD106, shows considerable potential in all grain sorghum areas of South Dakota. Another release of a mid-season grain sorghum hybrid, RS506,

and SD104 (an early variety and male parent of hybrid RS506) have provided superior yield qualities. Statewide yield average of 82 bushels per acre for this new hybrid compares with 76 bushels for Agricultural Experiment Station hybrids now commonly used.

SD106 and SD104 are especially adapted to narrow rows and delayed planting.

The 1972 breeding nursery conditions were very unfavorable for seed production so the winter greenhouse plantings included hybrid seed production for 1973 yield tests. Test plantings include Regional Uniform tests at four locations, advanced breeding entries at six locations, preliminary breeding entries at four locations and late planted early maturing narrow row entries at five locations. Breeding nursery plantings include the usual crossing block entries, backcrosses and advanced breeding lines as well as two groups of lines segregated for resistance to greenbugs. Emphasis is on early lines and hybrids with drought resistance and cold tolerance.□

Objective No. 15—Reduce Feed Costs in Livestock and Poultry Operations

FEEDING livestock and poultry profitably in between the cost-price squeeze takes continual study of new developments — by both the producer and by the researcher. The Agricultural Experiment Station through the years has aided South Dakota producers with a variety of research on cattle, sheep, swine and poultry.

Some of the most recent research includes:

Lambs fed high energy finishing diets gained faster when diets were supplemented with soybean meal in comparison to urea. Most of the advantage for soybean meal was during the first 3 weeks of the experiment. This period of apparent adaptation is an important consideration in feeding urea to feedlot lambs since it may make up a large part of the total feeding period. Supplementing with surfur was of no benefit in improving performance during this period of urea adaptation. Similar results were obtained with steers but the period of adaptation generally makes up a small part of the total feeding period. Supplying additional protein as soybean meal does not appear to overcome this period of reduced performance for either cattle or sheep upon introduction of urea to the diet as a major part of the total protein.

Several experiments have been completed on methods of processing of grain, effects of levels of roughage and effects of moisture content of roughage and concentrates. Emphasis is being devoted more to storage methods in current phases of the research. Cattle feeding trials recently completed showed a slight advantage for haylage over hay in high grain diets which is in agreement with several previous experiments. Bacitracin up to 280 mg. per head daily did not result in any improvement in performance of cattle fed either high roughage or high concentrate diets.

Growth Stimulaters

Experiments have shown that zeranol (a growth stimulating implant) improves rate of gain and feed efficiency for feedlot cattle and sheep about equal to that obtained from diethylstilbestrol (DES). Bulls do not appear to respond to the implant but gain faster and more efficiently than implanted steers. The advantage for bulls over steers was greater when fed high energy diets from weaning to market.

Rate of gain for cattle during a backgrounding operation should depend largely upon available feed supplies and market demand for various weights of feeder cattle. Cattle feed for various rates of gain up to 2.5 pounds daily, gained at high rates when put in drylot and fed high concentrate rations. Time required for drylot finishing was reduced with increasing rates of backgrounding rates of gain but with little effect on carcass characteristics when marketed at similar weights.

Weaning systems for range lambs is being intensively investigated at the Agricultural Experiment Station. Data from the 1972 season show only 68% of the lambs on native range weighed 90 pounds or more at the termination of the trial while 90% of the drylot group weighed 90 pounds or more at the same age. Performance of lambs weaned and placed on sudan sorghum pasture was nearly equal to those in drylot. A total of 130 wether lambs born in 1973 were randomly assigned at 80 days of age to one of three management systems for finishing: (1) weaned and placed on feed in drylot; (2) pastured with their dams on native range until market weight; or (3) pastured with their dams on native range until about 110 days of age, weaned and placed on feed in drylot for finishing.

A preliminary summary of lambing performance at 12 months of age shows that: (1) a large percent of the crossbred ewes lambed and dropped more lambs per ewe lambing; (2) a high postweaning level of nutrition resulted in 64% of the ewes lambing vs 55% for those on the moderate level postweaning; and

(3) 63% of the twin born dams lambed at 12 months of age vs 56% of the single born dams. Subsequent lifetime production information will be collected to further evaluate these treatment effects.

Swine Studies

Research on protein and amino acid requirements of growing swine studied the effect of lysine and methionine supplementation of corn-soy diets containing 14% crude protein from 35 to 110 pounds and 11% crude protein from 110 to 200 pounds. Results indicate the pig from 35 to 110 pounds requires about 0.75% lysine and the pig from 110 to 200 pounds requires about 0.53% lysine. These levels are slightly higher than those suggested by the National Research Council (0.7% lysine for 44-77 pound pigs and 0.5% lysine for the finishing pig).

Other research indicates that 125, 187.5 or 250 parts per million of copper in the diet (fed as copper sulfate) increased gains of pigs during the first 8 weeks of the feeding period but gains were best when 250 p.p.m. of copper were fed. There were no consistent differences in performance of pigs fed the copper for 8 weeks or for the entire experiment (to market weight) except in liver copper storage which was increased with increased levels of copper fed continuously to slaughter weights.

Molds found in some feeds apparently are beneficial and others may have a detrimental effect, according to cooperative research between the Departments of Animal Science and Plant Science. Increased chick growth rate and feed efficiency were noted as the most consistent responses from use of two of several fungus species inoculated into cracked and sterilized soybeans used in connection with diets considered adequate for broiler type chicks. The improvement appeared to correlate with increased levels of essential amino acids found in the cultured soybeans. Another experiment used a toxin produced by molds that are widely distributed in soil and decaying organic matter and frequently are associated with molding feed. Feeding 1, 2, and 4 parts per million of the ochratoxin to hens increasingly reduced the production and the hatchability of fertile eggs. The toxin depressed subsequent performance of the progeny for the first 2 weeks of life although the detrimental effect was not observed at the end of the fourth week.

Better Use of Soybeans

Addition of 1% or 2% dried whey to haylage as a preservative also improved quality of this type of dairy feed as indicated by increased lactic acid, decreased acetic acid and reduced pH. Amounts of poorly digestible fiber components were lower in whey-treated haylages, indicating improved fermentation during ensiling.

While soybeans provide a high quality protein, they also contain factors which inhibit animal growth and cause pancreatic enlargement. This isn't a major problem in soybean meal because the growth inhibitors are inactivated through a heating process. This heat treatment, however, undesirably alters the protein for use in milk replacers for dairy calves and in other food products where soy protein concentrates can be used. Research is attempting to isolate two growth inhibitors in a soybean whey fraction byproduct, currently discarded during processing, which contains 20% of the total solids and 10% of the total soy protein.

Dairy scientists are using an experimental chemical to artificially induce pregnant dairy cows to bear their calves earlier than normal. Idea behind the research is that modern dairy cows give birth to larger calves, often resulting in high death losses and other difficulties. Experimental cows calved about 5 days earlier and calves weighed about 7 pounds less at birth than "normal" calves. Health and performance of all calves—early induced or not—were similar. Milk production on reproductive performance were similar for all cows.

Importance of vitamin E to dairy cows is not actually known but SDSU scientists are attempting to learn more about it. The modern dairy cow is much different from one of 20 years ago and vitamin E deficiency aspects (as well as others) may show up in even higher producing cows of the future. Some ramifications include: rupture of red blood cells (hemolysis) occurs in vitamin E deficient individuals; a cow deficient in vitamin E will likely give milk low in that substance; vitamin E is a good antioxidant so milk low in this vitamin may be more susceptible to developing off-flavors (oxidized or "cardboardy" flavors).

"Headstart" for Calves

Giving dairy calves a "headstart" by feeding them colostrum for up to 4 weeks of age has resulted in slightly higher weight gains than those fed whole milk. Colostrum, the "first drawn milk," provides a natural rich source of nutrients and antibiotics for new-born animals. Most dairymen feed a calf colostrum for 2 to 3 days although a cow produces enough to supply a calf with liquid for about 3 weeks. Experimentally, SDSU scientists are feeding undiluted frozen colostrum for up to 4 weeks, although indications are that colostrum possibly should be diluted prior to feeding this length of time to reduce scours.

If soybeans price themselves out of the realm of livestock feed, a new experimental rapeseed made into meal may help solve the protein supplement problem, especially for dairy calves. Rapeseed production is increasing—especially in Canada—to meet growing demands for rapeseed oil, used interchangeably with soy oil in many applications. The big difficulty encountered at SDSU was that to a calf, rapeseed meal tastes awful, even when "sweetened" with molasses. One approach is to somehow con calves into eating it because the amount of rapeseed meal from the new experimental variety consumed to gain a pound of weight—feed efficiency—was as good as with soybean meal.□

Objective No. 16—Establish More Accurately the Shelter of Livestock and Poultry Needed

RIGHT from the start, research on livestock and poultry shelter in South Dakota must take into consideration three basic factors: comparatively large and expensive structures are involved, extreme cold, and extreme heat.

Considerable research has been done regarding scale model structures and how readings from these experiments can be applied to full size buildings. This method is not only more economical from a research standpoint, but it also provides a system by which factors such as wind, temperatures and humidity can be controlled to provide a variation. In ⅛th size model buildings made of galvanized or white painted metal, no significant differences in environmental temperatures were noted during winter operation. Summer studies are also being made. Based on 1/20th size model studies, continuous open ridge vents are being recommended for open front beef buildings.

Climate and Shelter

Climate itself is included in special weather studies conducted at the Agricultural Experiment Station. Considerable work is done faster and better by computer for South Dakota weather records, some of which date back more than a century. An analysis of winds is underway with regard to averaging period and variations across the state. Experiments are finding the averaging period of 1 hour gives wind velocities significantly different from those published by the National Weather Service of a 2-minute sample in each hour. The statewide study will help farmers and ranchers to get better values of cooling effect of winter weather on man and animals, better design of animal shelters, better estimates of wind pressures on buildings and dynamic loads due to gusts, better values of evaporation and evapotranspiration in water use of crops.

Monitoring of environmental conditions in open front and closed beef units are being correlated with climatic conditions and livestock performance. In a closed confinement beef building housing 47 head of 530 to 640 pound steers, total heat averaged 2,870 B.t.u./hr/head (2,180 latent and 690 sensible) as temperatures ranged from 31 degrees to 95 degrees (F.).

Techniques are being developed to study effects of climatic conditions on surface temperatures of dairy cattle. Experimental calf hutches are instrumented for monitoring to compare with climatic conditions.

Three types of poultry houses are being used to obtain data for evaluations of environmental effects on egg production.

Beef unit ventilation rate designs have been correlated with temperature and relative humidity. It was found that manure tanks added 205 B.t.u./hr/head of latent heat and removed 175 of sensible heat from the ventilation design load.

Normal summer ventilation of swine breeding-gestation units is recommended as research results have not indicated a significant advantage in using air conditioning.□

Objective No. 17—Adapt the Soybean More Effectively to South Dakota

NARROW row soybeans appear to be the best planting method for many South Dakota growers, according to SDSU research.

These narrow rows—10 to 14 inches apart—often provide a larger crop that is easier to harvest. Yield increases were greater in northeastern and east-central South Dakota than in the southeastern part. Normally South Dakota soybeans are planted in 30- to 42-inch rows.

Yield increases of 2% to over 50% have been obtained in experimental plots with rows planted 12 inches apart with a drill. Narrow rows also show advantages in better erosion control because of more summer ground cover and more stubble and mulch. Pod heights for easier harvesting can be somewhat controlled by plant and row spacing. Soybeans set lowest seed pods at the third node from the base but soil ridging during cultivation causes this node to be nearer ground level for wide row beans than for uncultivated narrow row beans.

Effective early weed control is absolutely necessary and without it a major problem can develop with

narrow rows or drill planted soybeans.

In other research, a comparison of 7-inch row spaced soybeans planted with a grain drill to 30-inch row spacing planted with a toolbar planter resulted in yields being the same for both methods in southeastern South Dakota. Plant populations were 150,000 an acre.

Plant nutritional aspects should not be ignored on a medium to low phosphorus supplying soil, plant researchers point out. A sideband application of phosphorus has increased soybean yields 3 to 4 bushels an acre over an 8-year period.

Growth and development of soybeans are influenced by length of day and night. Under continuous light, some varieties will never produce flowers.

Length of day for soybean growth is controlled by planting date, consequently planting date has a marked influence on growth and development of soybeans.

When the vegetative period between emergence and flowering is shortened due to a daylight period other than optimum (a reflection of planting date) there is frequently a reduction in both yield and height of soybeans.

The earliest planting date (May 18) in one experiment had the tallest beans at first flowering and yielded the most beans. Both early and late varieties were shorter at first flowering when planting date was delayed to June 6 and yielded less than the earlier planting dates. □

Objective No. 18—Develop and Modify Agricultural Machines for Greatest Labor Efficiency

AGRICULTURAL machinery is being designed in Agricultural Experiment Station research to improve comfort of the operator, to improve operation of the implement, or, in one instance, to put animals themselves to work operating feed units.

There's a lot of uncomfortable hot and cold tractor driving for both men and women in South Dakota. Past and present research in operator comfort at SDSU has had direct effect in stimulating manufacturers to produce quieter, safer, and more comfortable tractor cabs for all farmers.

SDSU agricultural engineers have constructed an "environmental test facility" to determine tractor cab climate control needs for South Dakota farmers and ranchers. The unit is self contained, portable, and will accommodate a typical manufactured cab. The unit provides control for cooling, heating and humidification of inlet air to a cab with rates of flow variable from 200 to 700 cubic feet per minute. SDSU summer school students began voluntarily cooperating in June 1973 to help researchers obtain a subjective rating of comfort. Each student sat in the instrumented and climate-controlled tractor cab for 50 minutes and then rated reactions.

Farmer Cooperation

In addition to the campus test facility, a Brookings County farmer cooperated in research in the field to determine climate extremes in tractor cabs with minimum environment control. His cab was instrumented to automatically record temperatures for cold and hot field work in 1973.

A power driven hay sampler which provides a 4-foot core slightly more than 2 inches in diameter was designed, constructed and put into use. Nearly 200 samples have been taken from haystacks for analyses to determine protein, neutral detergent fiber, acid detergent fiber, lignin, ash and moisture. These sampling techniques for determining quality also provide data indicating that South Dakota hay can be harvested in the new large "packages" in the 30% to 40% moisture range with satisfactory quality.

Cold Air Drying

An apparatus has been constructed to allow cold air drying of hay handled with commercially available stack handling equipment. The research is to study effect of three different methods of controlling air flow on drying time and hay quality as indicated by digestible protein. Research has shown an increased efficiency in cold air drying of conventionally handled long and chopped hay using time clock and cooling thermostat control systems as compared to continuous air flow systems.

Preliminary research has started on a range unit operated by the beef cow itself which would add grain to a liquid supplement feeding system.

Objective No. 19—Understand the Farm Commodity Market Structure and Market Influences

GRAIN transportation survey data has been continued and preliminary consideration is being given to development of an input-output model to quantify the relationship between the wheat producing sector and other parts of the economy. This should help in analyzing the impact of various changes in the state transportation system upon the wheat sector which is a major user of rail and truck transportation.

Further progress was made in developing and testing the base model of South Dakota's cattle feeding industry and in accumulation of demand, marketing, price and transportation data. The model for analysis of the patterns of input prices and marketing that may provide incentives or disincentives for expansion of cattle feeding includes prices of beef cattle and grains (including high protein feeds such as soybean meal) as well as the costs of marketing live cattle. A new method for efficiently comparing the location of the feeder cattle and the feed supplies in the state was developed and will be used in early fiscal 1974 analysis. Preliminary work has been completed to integrate backgrounding activities into an analysis of cattle feeding opportunities in South Dakota.

Research is continuing to identify and analyze marketing alternatives to producers and grain elevator managers with a secondary purpose to evaluate cost-saving techniques available for farm supply businesses. Data is being gathered and analyzed for a publication and slide and script program on use of grain elevators' use of futures.

A marketing study of the retail fertilizer industry presented an overall view of some of the major factors affecting the survival of dealers in the industry and the adjustments that both existing and potential entrants into the industry must face and plan for in order to be efficient and achieve continued growth. Analysis of the costs of retailing fertilizer provided data on the potential savings possible from increased size of operation. For example, an estimated reduction in costs of $3.51 per ton was found to be possible from increasing annual sales from an average of 324 tons to an average of 1,051 tons. The structure analysis indicates that substantial savings potential exists for many retailers as many had sales approximating the average of 324 tons.□

Objective No. 20—Collect Information on the Human Resource in South Dakota

SOUTH Dakota population and human resource studies reveal several unique factors:

South Dakota experienced a gain of 8,971 persons aged 65 years and over for the decade 1960 to 1970, in spite of a loss in total population.

In spite of the decline in numbers of children under 5 years, due to lower birth rates, the number of young people ages 15-35 had the largest increase for any age group.

In all population categories (ages) the trend was from rural to urban centers.

The proportion of non-white to white increased except in the over 75 age category.

For the first time in South Dakota history, females in the population outnumbered the males. The ratio of males decreased from a high of 119 per 100 females in 1910 to a low of 98 in 1970.

South Dakota ranked fifth in the nation in proportion (12.1%) of aged to total population of the state.

In the decade 1960 to 1970 South Dakota continued previous patterns of rural depopulation, urbanization and net out-migration. Increases in nuptuality and decreases in fertility and child mortality were also recorded.

Research on Poverty

Research on poverty has shown that much of it is due to under-employment rather than unemployment—many people are employed but simply do not make enough money to supply family needs.

The South Dakota poverty problem is different in many respects from that found in metropolitan areas. Problems of adaptability arise when nationally oriented poverty programs do not take into consideration the needs of most low income families in this area.

Because the majority of household heads are already fully employed, programs designed to provide retraining and subsequent employment may not succeed.

Other research on population and human resources includes:

A published report ranked the 67 counties of South Dakota on population, housing and farm census data. It included 118 tables with appendix of basic terms and definitions. Data on characteristics of the population of counties 1970 and change from 1960, net migration number and rates, vital rates, family income and poverty levels, housing characteristics and data on South Dakota farms 1959 and changes from 1954 are included.

Additional data were obtained to provide a base line to measure changes in institutional structures during the construction phase of the Big Stone Lake power plant and to determine how the institutions adjusted after the power plant was "on the line" and construction completed. In general, respondents were rather uncertain about the severity of environmental problems in the Big Stone Lake area before the power plant was constructed. The data from the original 1970 Benchmark study indicated significant relationships between residential variables, participation in organizations, religious preference, and attitudes toward further industrial development. Farm residents perceived more severe environmental problems than urban residents.

Manpower Programs Studied

Analysis continued of program participation and success rates for the various manpower programs in South Dakota. Comparisons were made of white and non-white participants and the socio-economic variables associated with success or lack of success in the manpower programs. The analysis is directed toward developing a means of projecting manpower training needs and providing a means of predicting successful program completion based on upon identifiable socio-economic characteristics of prospective participants.

Preliminary review and formulation of research design were completed relating to an attitudinal study investigating the demographic and socio-economic factors associated with water resource development, and attitudes of South Dakota residents to water resource development.□

Miscellaneous

A STUDY using three antibiotic preparations for dry cow treatment of bovine mastitis has been completed and data are being tabulated in Veterinary Science Department research. Twelve herds containing more than 800 cows were used in the study.

Estimates that 20,000 calves are lost annually in South Dakota through abortion and stillbirth represents financial losses of nearly $3 million. The Veterinary Science Department is emphasizing research to aid farmers and ranchers to at least reduce losses from cattle abortion. Causes of abortion vary greatly, but include such factors as heredity, injury, toxins or poisons from plants or chemicals, hormone imbalances, nutrition and a wide variety of infectious diseases. Research data from diagnostic work on aborted fetuses indicates that Infectious Bovine Rhinotracheitis (IBR) is the most commonly diagnosed cause of abortion in South Dakota cattle. A properly immunized cow will be protected from IBR-caused abortion. Among advantages of a new immunofluorescent technique for diagnosis of IBR abortion developed at SDSU is that results can be available within 2 hours after necropsy, whereas older techniques require 3 to 4 days. Vibriosis, a venereal disease caused by a bacterium, is the second most common abortion cause diagnosed in the state. This infection also causes temporary infertility in cows and greatly reduces reproductive efficiency. The infection can be controlled with a good vaccination program.

Veterinary research continues on isolation of viral agents from swine abortions, stillborns and for other reproductive problems of swine. One result is a finding that sows which have experienced an infection with reovirus will most likely conceive and farrow normal litters.

Nearly 250 *Escherichia coli* isolates have been examined in veterinary research on colibacillosis and salmonellosis in calves and pigs in

attempts to identify antigens possessed by each isolate. The predominant serotype in the swine research has not been previously reported. Experiments continue toward development of tests to differentiate enteropathogenic from non-enteropathogenic *E. coli*. To date, a baby mouse test appears promising.

Attempts to demonstrate epizootic hemorrhagic disease by mouse inoculation or deer cell culture techniques yielded negative results in veterinary experiments relating to deer diseases. Probable cause of deer disease was determined in 69% of the cases investigated.

Selenium Research

Studies were completed in the Station Biochemistry Department on the potentiating effect of arsenite on the toxicity of various methylated selenium derivatives and on the

conversion of the methylated selenium derivatives to volatile compounds which are exhaled by rats. Studies were also completed to determine the effect of the route of administration of arsenite on selenium toxicity. Contrary to reports elsewhere, there seemed to be little difference in the effect of arsenite on selenite toxicity whether the arsenite was administered in the water or in the feed. The method developed for the analysis of plant materials for selenium has been compared to neutron activation analysis and subjected to other studies and found satisfactory for use for papers and other processed plant materials. The stability of inorganic selenium in a variety of premixes has been studied, and it has been found that when kept dry and stored at reasonable temperatures either selenites or selenates should be stable over long periods of time with a wide variety of carriers.

Effects of polychlorinated biphenyls (PCB) and DDT on white pelicans revealed that liver weight was increased by the PCB treatment and decreased by the DDT treatment when taken as percent of body weight. Spleens were heavier on the PCB treatment.

Variations in population of adult hens subjected to irradiation as embryos resulted in size reduction and eye abnormalities. Three subsequent trials indicated that the smaller size of the adults in the treated groups is not measurable at hatching time. Also in relation to this research, selected lines of radiation-resistant chickens are being maintained and an effort is being made to recover the "Woolly" mutation as well as to expand the double oviduct stock.

Campus Masterplan

The SDSU Campus Masterplan was updated, expanded, and detailed to include defined pedestrian and vehicular circulation systems, locations for proposed future research, housing, academic, and service buildings, recreation areas, and open spaces. Numerous preliminary plans were prepared for use by architectural and engineering consultants as site plans for the new Student Union, HPER building, Young and Binnewies Halls and dining complex, HEN building, new married student housing complex Rotunda Classroom Building and five major parking lots. Detailed plans were prepared for facility improvements at the Southeast South Dakota Experiment Farm, Pasture Research Center at Norbeck, Horticulture Field Laboratory, and McCrory Gardens public areas. The proposed campus lighting plan consisting of several hundred new light standards was reviewed and considerably altered. Bicycle parking areas were designed for most of the campus. Plans were prepared for new intramural and varsity football, softball, and soccer fields. A golf laboratory with driving range and putting green, several ice skating rinks and other recreation areas were completed, some in conjunction with student dormitories. Two new campus greens with walks, plantings, drainage, earth sculpture, plaza and sitting areas were designed. Planting plans were prepared for many areas of the old portion of the campus and for all of the new eastern half of the campus. Assistance was provided through planning and consultation with the administration of the University of South Dakota to organize and update the Vermillion campus.

The role of Western equine encephalitis (WEE), Venezuelan equine encephalitis (VEE), and St. Louis encephalitis (SLE) viruses in South Dakota's horses, pheasants, waterfowl and other wildlife and human populations was investigated. Seventy-eight arboviruses representing six different types of virus were isolated from over 200,000 mosquitoes trapped in irrigated (Oahe and Angostura) and non-irrigated wildlife refuges (LaCreek) and farmstead sites. *Culex trasalis* was found to be the major South Dakota mosquito transmitting WEE and had a virus infection rate as high as 13 per 1,000 mosquitoes. Thirty-six WEE and 17 SLE viruses were identified. A total of 13.7% of the humans in Angostura Irrigation District developed WEE antibodies during the 1972 mosquito season. Tested for WEE and VEE virus antibody were 351 small rodents, 153 Giant Canada geese and 312 horses. None showed any evidence of VEE, but over 10% showed evidence of WEE virus antibody. Horses from 18 out of the 38 South Dakota counties tested showed antibodies to WEE virus.□

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A (7/1/72)
W. F. Payne, Ph.D. ..... Assistant Professor
G. D. Rose, Ph.D. ..... Professor
R. K. Rudel, M.S. ..... Assistant Professor
K. O. Scofield, B.S. ..... Assistant
A. B. Sogn, M.S. ..... Assistant Professor
S. J. Smith, M.S. ..... Assistant Professor
A (8/15/72)
R (6/1/73)
E. O. Ullrich, M.S. (USDA) ..... Assistant Professor
J. E. Wiebe, Ph.D. ..... Assistant Professor
R (1/9/73)

ENTOMOLOGY-ZOOLOGY

R. J. Walstrom, Ph.D. ..... Professor and Head
E. U. Balsbaugh, Ph.D. ..... Associate Professor
T. F. Branson, Ph.D. (USDA) ..... Assistant Professor
A. Greichus, Ph.D. ..... Associate Professor
R. D. Gustin, M.S. (USDA) ..... Instructor
E. J. Hugghins, Ph.D. ..... Professor
P. A. Jones, Ph.D. ..... Associate Professor
R. W. Kieckhefer, Ph.D. (USDA) ..... Associate Professor
V. M. Kirk, Ph.D. (USDA) ..... Professor
J. L. Krysan, Ph.D. (USDA) ..... Associate Professor
B. McDaniel, Ph.D. ..... Professor
E. E. Ortman, Ph.D. (USDA) ..... Professor
M. H. Roller, Ph.D. ..... Associate Professor
W. N. Stoner, Ph.D. (USDA) ..... Professor
G. R. Sutter, Ph.D. (USDA) ..... Associate Professor
R. N. Swanson, Ph.D. ..... Professor

HOME ECONOMICS

Frances M. Hettler, Ph.D. ..... Professor and Head*
Dorothy Deethardt, M.S. ..... Assistant Professor
Louise Guild, M.S. ..... Assistant Professor
Hildegarde Johnson, Ph.D. ..... Professor
W. A. Johnson, Ph.D. ..... Assistant Professor
Lillian O. Lund, M.S. ..... Professor
Cora R. Sivers, M.S. ..... Associate Professor
*Deceased 6/9/73

HORTICULTURE-FORESTRY

R. M. Peterson, Ph.D. ..... Professor and Head
D. G. Adams, Ph.D. ..... Associate Professor
R (7/27/72)
H. G. Cady, B.S. ..... Assistant
R (8/31/72)
P. E. Collins, Ph.D. ..... Associate Professor
N. P. Evers, B.S. ..... Assistant
L. C. Johnson, M.S. ..... Associate Professor
P. E. Nordstrom, Ph.D. ..... Assistant Professor
A (9/15/72)
D. P. Prashar, Ph.D. ..... Associate Professor
W. A. Urdahl, B.S. ..... Assistant
J. R. Waples, B.S. ..... Assistant

MICROBIOLOGY

R. M. Pengra, Ph.D. ..... Professor and Head
Janice K. Fuller, B.S. ..... Assistant
D. R. Larson, M.S. ..... Instructor
R (8/15/72)
Carol Ann Lunder, B.A. ..... Assistant
P. R. Middaugh, Ph.D. ..... Professor
G. C. Parikh, Ph.D. ..... Professor
R. S. Shave, B.S. ..... Instructor
R. J. Stangland, M.S. ..... Instructor
Suzanne VanMeeteren, B.S. ..... Assistant
R (8/25/72)
T. R. Wilkinson, Ph.D. ..... Assistant Professor

PLANT SCIENCE

R. A. Moore, Ph.D. ..... Professor and Head
W. E. Arnold, Ph.D. ..... Assistant Professor
F. L. Bode, B.S. ..... Assistant
J. J. Bonnemann, M.S. ..... Assistant Professor
G. W. Buchenau, Ph.D. ..... Associate Professor
B. H. Byrnes, B.S. ..... Assistant
P. L. Carson, M.S. ..... Professor
J. D. Colburn, M.S. ..... Assistant Professor
C. R. Cowley, B.S. ..... Assistant
A (7/1/72)
D. C. Curtis, B.S. ..... Superintendent Pasture Research Center
C. D. Dybing, Ph.D. (USDA) ..... Professor
G. W. Erion, M.S. ..... Assistant Professor
P. D. Evenson, M.S. ..... Assistant Professor
L. O. Fine, Ph.D. ..... Professor
C. J. Frazee, Ph.D. ..... Professor
W. S. Gardner, Ph.D. ..... Professor
H. A. Geise, M.S. ..... Instructor

E. D. Gerloff, Ph.D. (USDA) ..... Associate Professor
R. G. Hoeft, Ph.D. ..... Assistant Professor
M. L. Horton, Ph.D. ..... Associate Professor
J. R. Jenison, B.S. ..... Assistant
S. G. Jensen, Ph.D. (USDA) ..... Associate Professor
D. G. Kenefick, Ph.D. ..... Professor
R. C. Kinch, M.S. ..... Professor
Q. S. Kingsley, M.S. ..... Assistant Professor
C. R. Krueger, Ph.D. ..... Associate Professor
A. O. Lunden, Ph.D. ..... Associate Professor
C. J. Mankin, Ph.D. ..... Professor
V. K. Mosley, B.S. ..... Assistant A (7/1/72)
C. M. Nagel, Ph.D. ..... Professor
T. C. Olson, Ph.D. (USDA) Associate Professor
W. B. O'Neal, B.S. ..... Assistant
J. D. Otta, Ph.D. ..... Assistant Professor
L. H. Penny, Ph.D. (USDA) ..... Professor
P. B. Price, Ph.D. (USDA) ..... Professor
R. W. Pylman, Ph.D. ..... Associate Professor
D. L. Reeves, Ph.D. ..... Assistant Professor
J. G. Ross, Ph.D. ..... Professor
M. D. Rumbaugh, Ph.D. ..... Professor
G. Semeniuk, Ph.D. ..... Professor
D. B. Shank, Ph.D. ..... Professor
D. G. Shannon, B.S. ..... Assistant
F. E. Shubeck, Ph.D. ..... Professor
J. D. Smolik, M.S. ..... Assistant
R. T. Thaden, B.S. ..... Assistant R (6/30/73)
J. R. Thysell, M.S. (USDA) Assistant Professor
R. C. Ward, Ph.D. ..... Assistant Professor
J. B. Weber, B.S. ..... Instructor
D. G. Wells, Ph.D. ..... Professor
F. C. Westin, Ph.D. ..... Professor
E. M. White, Ph.D. ..... Professor

PUBLICATIONS

J. L. Pates, M.S. ..... Agricultural Information Editor
F. J. Shideler, M.S. ..... Agricultural Publications Editor
L. M. Jorgensen, B.S. ..... Agricultural News and Feature Editor
Mary Brashier, M.S. ..... Assistant Agricultural Publications Editor
Wanda Leonard, B.S. ..... Assistant Agricultural Publications Editor R (2/1/73)

RURAL SOCIOLOGY

H. M. Sauer, M.S. ..... Professor and Head
R. M. Dimit, Ph.D. ..... Professor
O. E. Lanham, M.S. ..... Assistant Professor
M. P. Riley, Ph.D. ..... Professor
R. T. Wagner, M.S. ..... Assistant Professor

STATION BIOCHEMISTRY

O. E. Olson, Ph.D. ..... Professor and Head
R. J. Emerick, Ph.D. ..... Professor
G. F. Gastler, M.S. ..... Associate Professor
Yvonne A. Greichus, Ph.D. Associate Professor
P. L. Guss, Ph.D. (USDA) Associate Professor
Alice Holm, M.A. ..... Assistant R (6/30/73)
A. W. Halverson, Ph.D. ..... Professor
L. C. Novotny, B.S. ..... Assistant
I. S. Palmer, Ph.D. ..... Associate Professor
E. I. Whitehead, M.S. ..... Professor

VETERINARY SCIENCE

M. W. Vorhies, D.V.M. Associate Professor and Head A (4/1/73)
E. J. Bicknell, D.V.M., Ph.D. ..... Professor and Head R (4/15/73)
C. A. Daley, D.V.M., M.S. Assistant Professor
R. P. Ellis, Ph.D. ..... Assistant Professor
G. S. Harshfield, D.V.M. Professor Emeritus
Sharon Irvine, B.S. ..... Assistant R (6/5/73)
M. M. Kieffer, B.S. ..... Assistant
C. A. Kirkbride, D.V.M. ..... Assistant Professor
W. U. Knudtson, M.S. ..... Instructor
T. J. Langpap, B.S. ..... Assistant
Carol Ann Larson, B.S. ..... Assistant R (10/31/72)
Pamela Leslie, B.S. ..... Assistant A (6/1/73)
Janet Mattson, B.S. ..... Assistant
J. P. McAdaragh, M.S. ..... Assistant Professor
Lynne McCrow, M.S. ..... Assistant A (11/15/72)
C. F. Meinecke, D.V.M., M.S. ..... Assistant Professor R (10/30/72)
Connie Phillips, B.S. ..... Assistant R (4/25/73)
R. L. Pierce, Ph.D. ..... Instructor
D. E. Reed, Ph.D. ..... Associate Professor
M. G. Robl, Ph.D. ..... Assistant Professor R (7/31/72)
Hazel J. Shave, M.S. ..... Assistant
I. J. Stotz, B.S. ..... Assistant
J. B. Taylor, D.V.M. ..... Professor Emeritus
K. Wohlgemuth, D.V.M., B.A. ..... Instructor A (7/1/72)

WILDLIFE AND FISHERIES

J. M. Gates, Ph.D. Assistant Professor and Head A (9/1/72)
D. R. Progulske, Ph.D. ..... Professor and Head R (9/29/72)
R. L. Applegate, M.S. (USDI) ..... Instructor
R. B. Dahlgren, Ph.D. (USDI) ..... Instructor
L. D. Flake, Ph.D. ..... Assistant Professor A (10/1/72)
D. C. Hales, Ph.D. (USDI) Associate Professor
R. L. Linder, Ph.D. (USDI) ..... Professor
J. G. Nickum, Ph.D. ..... Associate Professor

AGRICULTURAL RESEARCH AND EXTENSION CENTERS

Cornbelt (PO Beresford)
R. M. Luther, Ph.D. ..... Research Manager
B. Lawrensen, B.S. ..... Agronomist
James Valley (PO Redfield)
R. C. Ward, Ph.D. ..... Research Manager
L. B. Dye ..... Superintendent R (12/4/72)
West River (PO Rapid City)
J. A. Minyard, M.S. Area Extension Livestock Specialist

FULL TIME EQUIVALENT

The Agricultural Experiment Station FTE's for fiscal years 1973 and 1974 are:

	1973	1974
Professor	38.71	33.61
Associate Professor	23.61	22.92
Assistant Professor	26.76	20.49
Instructor	7.68	3.9
Non-Tenured	77.13	73.48
	173.89	154.4

SOUTH DAKOTA AGRICULTURAL EXPERIMENT STATION—YEAR ENDED JUNE 30, 1973

Source of Funds	Expenditures 6/30/72	6/30/73
1. State Appropriations (General Fund)	$2,198,597.03	$2,302,145.00
2. Continuing Federal Appropriations (State Treasurer)	876,844.00	924,804.00
3. Continuing Federal Appropriations (Local)	36,537.00	36,573.00
4. Federal Grants and Contracts (USDA)	39,593.60*	50,607.27
5. Federal Grants and Contracts (Not USDA)	127,277.39	134,538.16
6. State Agencies Grants	104,559.73*	169,433.65
7. Private Grants and Contracts	126,517.68	98,837.72
8. Internal and Statewide Services	151,805.35	180,722.23
9. Industry Services	49,956.84	81,560.05
10. Replacement Livestock Purchases	254,893.95	279,929.85
TOTAL	$3,966,582.57*	$4,259,150.93
Sales Income to General Fund	$ 335,200.57	$ 274,405.82
Net Support from General Fund	$1,863,396.46	$2,027,739.18

*Reclassification from 1972 Report.

Recent Publications Involving Goals/Objectives
Agricultural Experiment Station
South Dakota State University

Objective 1—Expand production "belt" of corn to the north and west.

Bonnemann, J. J. 1972 Corn Performance Trials. Circ. 208, Feb. 1973, Ag. Exp. Sta. SDSU.

Shank, D. B. and C. M. Nagel. Contrib. to Rept. Uniform Evaluation Tests. Reg. Publ. 213, U. of Mo., 1972.

Shubeck, F. E. Continuous Corn Shows Good Results in South Dakota Trials. The Farmer, 91:5, March 1973.

Shubeck, F. E. Populations, Not Row Width, Critical in Drought. Crops and Soils. 25:6, March 1973.

Objective 2—Expand the winter wheat belt north.

Fine, L. O. Mineral Content of South Dakota Bread Wheats: Extent and Nature. Agron. J. V64, Nov.-Dec. 1972.

Objective 3—Increase production efficiency of the beef cow.

Deutscher, G. H. Current Cow-Calf Managament Research Conducted in West River Area. Mimeo. W. Riv. Lvk. Conf. Mar. 8, 1973.

Dinkel, C. A. and D. A. Bush. Genetic Parameters Among Production, Carcass Composition and Carcass Quality Traits of Beef Cattle. J. An Sci. 36(5): 832 (1973).

Embry, L. B. Hormone or Hormone-like Products During Growing and Finishing of Cattle. Proc. 24th An. Montana Nutri. Conf., 1973.

Objective 4—Increase per acre yield of pasture and range land.

Allen, H. A. Grassland Production Systems Compared with Grain Production (North Central South Dakota). Bull. 600, Ag. Exp. Sta., SDSU, July 1972.

Evenson, P. D. and M. D. Rumbaugh. Effects of Root Zone Temperature on the Growth of Alfalfa. Rept. 23rd Alf. Impr. Conf., Ottawa, Canada, July 10-12, 1972.

Gartner, F. R. and W. W. Thompson. Fire in the Black Hills Forest-Grass Ecotone. Proc. An. Tall Timbers Fire Ecol. Conf., June 8-9, 1972.

Hansen, L. H. Recent Alfalfa Establishment Studies. Proc. 7th An. S. D. Seed Trade Assn. Shortcourse, 1973.

Hellickson, M. A., H. G. Young and D. P. Froehlich. Automatic Controls for Cold Air Hay Drying. South Dakota Farm & Home Research, XXIV, No. 1, Spring, 1973, Ag. Exp. Sta. SDSU.

Krueger, C. R. Switchgrass Establishment and Management. Proc. 7th An. S. D. Seed Trade Assn. Shortcourse, 1973.

Mariam, E. K. and J. G. Ross. Intermediate and Pubescent Wheatgrass Complex in Native Collections from Eastern Turkey. Crop. Sci. 12:472 (1972).

Ross, J. G. Increasing Water Utilization Efficiency of a Pasture Grass by Increasing Aftermath Through Plant Selection. Compl. Rpt. Proj. A-026-SDAK, Water Resources Institute, SDSU.

Rumbaugh, M. D. et al. Predicting Seed and Forage Yields of Alfalfa Open-Pollinated Progenies. Publ. 214, Oct. 1972, NC Reg.; and Tech. Bull 40, Ag. Exp. Sta., SDSU.

Semeniuk, G., M. W. Adams and M. D. Rumbaugh. Heritable Reaction in Some Alfalfa Populations in Field Nurseries to the Yellow Leafblotch Disease. Mimeo.

Thaden, R. *In vitro Digestibility of* Diallel and Polycross Progenies of Intermediate Wheatgrass. M.S. Thesis, SDSU, 1973.

Thompson, W. W. and F. R. Gartner. Interseeding in Western South Dakota. Soc. Rng. Mgt., 26th An. Mtg. Boise, Ida. Feb. 4-9, 1973.

Voelker, H. H. You Can Lose a Third of Your Alfalfa Crop. Hoard's Dairyman 118(10):681 (1973).

Weber, J. B. Intermediate Wheatgrass Seed Production Responses to Fertilizers and Cultural Practices. M.S. Thesis, SDSU, 1972.

White, E. M., W. W. Thompson and F. R. Gartner. Heat Effects on Nutrient Release from Soils Under Ponderosa Pine. J .Rng. Mgt. 26(1):22 (1973).

Objective 5—Learn to use irrigation water efficiently and effectively

Chu, S. T. Planning a Schedule for Irrigating Two Quarters of Alfalfa by One Center Pivot System. Paper NC72-306, 1972 An. Mtg. ASAE, Brookings, S. D.

DeBoer, D. W. and S. T. Chu. Development of Bi-level Drainage Theory. 72-731, 1972 Winter Mtg., ASAE, Chicago.

Frankenstein, R. F. Effects of Irrigation Application Depths on Corn Yield and Soil Moisture. M.S. Thesis, SDSU, 1973.

Horton, M. L. Soil-Plant-Water Envionment Research Proj. A-018-SDAK. Office of Water Resources Res., USDI, Washington. Feb. 1973.

——. Understanding and Improving the Soil-Plant Environment for More Efficient Utilization of Water. Compl. Rpt. Proj. A-018-SDAK, Pl. Sci. Prog. Rpt. 595.

—— and C. G. Carlson. Grain Sorghum Canopy Temperature Under Water Stress. Paper 72-718, ASAE Mtg., Chicago. Dec. 1972.

Kienholz, J. M. Evaluation of Bi-level Drainage Theory with a Viscous Analog. M.S. Thesis, SDSU, 1973.

Olson, O. E. and R. J. Emerick. Nitrates in Livestock Waters. FS603, SDSU Coop. Ext. Serv.

Sandhu, B. S. Growth, Development and Plant Temperature Characteristics of Oats Under Water Stress. Ph.D. Thesis, SDSU, 1973.

Stone, L. R. A Study of Energy and Water Transfer in Irrigated and Nonirrigated Sorghum. Ph.D. Thesis, SDSU, 1973.

——, M. L. Horton and T. C. Olson. 1973 Water Loss from an Irrigated Sorghum Field: I. Water Flux within and Below the Root Zone. Agron. J. 65:492-495.

——, —— and ——. 1973 Water Loss from an Irrigated Sorghum Field: II. Evapotranspiration and Root Extraction. Agron. J. 65:495-497.

——, T. C. Olson and M. L. Horton. Water Loss Estimates from a Fallow Soil. J. Soil and Water Cons. May-June 1973.

Objective 6—Learn how to raise the level of managerial skill on farms and ranches.

Adams, E. P., E. J. Williamson, B. Byrnes, R. C. Ward, P. L. Carson and R. Hoeft. Soils and Fertilizer Guide, 1973. Circ. 691, SDSU Coop. Ext. Serv.

Devine, R. J. The Effects of Livestock Waste on Some Soil Strength Characteristics and Selected Tillage Operations. M.S. Thesis, SDSU, 1973.

Gaarder, R. O. South Dakota's Beef Industry: Marketing Systems and Alternatives. Bull. 604, SDSU Ag. Exp. Sta., Oct. 1972.

Lytle, W. F. and S. T. Chu. Limiting Climatic Factors for Crops in South Dakota. Paper 72-714, ASAE.

Slyter, A. L. Effect of Breed of Sire, Level of Postweaning Nutrition and Type of Birth (Single vs. Twin) on Lambing Performance at 12 Months of Age. SDSU An. Sci. Series 73-4.

—— and W. R. Trevillyan. Weaning Systems for Range Lambs. SDSU An. Sci. Series 73-6.

Stone, L. R., T. C. Olson and M. L. Horton. Unsaturated Hydraulic Conductivity of Soils for Water Management. S. D. Acad. Sci., Apr. 1973.

Objective 7—Provide data and information about government and institutions in a useable form for decision-making.

Johnson, R. P. An Analysis of the Factors Influencing the Variation in the Per Capita Costs of South Dakota County Governments. M.S. Thesis, SDSU.

Riley, M. P. and E. T. Butler, Jr. South Dakota Population, Housing, and Farm Census Facts. Bull. 611, May 1973 (No. 4 in series), Ag. Exp. Sta., SDSU.

Satterlee, J. L. and M. P. Riley. Rural Poverty in Three Eastern South Dakota Counties. Bull. 602, Sept. 1972, Ag. Exp. Sta., SDSU.

Objective 8—Learn how to maintain a healthful and pleasant environment for South Dakotans.

Adams, D. G. and W. A. Urdahl. Temperature Controlled Floral Induction in Amazon Lily. *Eucharist grandiflora* Planch J. Am. Soc. Hort. Sci. 98(1):29-30 (1973).

Dahlgren, R. B., R. L. Linder and W. L. Tucker. Effects of Stress on Pheasants Previously Given Polychlorinated Biphenyls. J. Wild. Mgt. 36(3):974-978.

Elliott, C. R. and R. L. Linder. Use of State and Private Lands by Pheasants and Waterfowl in South Dakota. Am. Midl. Nat. 88(2):257-261.

Gardner, W. S. Ozone Injury to Tobacco Plants in South Dakota. Pl. Dis. Rptr. 57:106.

—— and J. Safford. Ozone Injury to Tobacco and Alfalfa in South Dakota. Phytop. (Abst.) 62:759 (1972)

——, K. Redman and J. Safford. Sensitive Medicinal and Poisonous Plants Monitor Ozone and 2,4-D Air Pollution in South Dakota. S. D. Acad. Sci. (Abst.) 51:268 (1972).

Gates, J. M. Nesting of the Woodcock in Brookings County, S. D. S. D. Bird Notes 25(1):6-7 (1973).

Gengerke, T. W. and J. G. Nickum. The Plankton and Benthos of Abbey Pond 1970 and 1971. Proc. S. D. Acad. Sci. 51:96-110.

——, —— and W. C. Thorn. The Physical-Chemical Limnology of a South Dakota Farm Pond, 1965-1971. Proc. S. D. Acad. Sci. 51:111-121.

Greichus, Y. A., A. Greichus and R. J. Emerick. Insectides, Polychlorinated Biphenyls and Mercury in Wild Cormorants, Pelicans, Their Eggs, Food and Environment. Bull. Envir. Contam. & Tox. 9(6):321 (1973).

Heidelbauer, R. J. and P. R. Middaugh. Graded Density Filters for Standardization of Fluorescence Microscopy. The Public Health Lab. 30(5):187 (1972).

Johnson, R. P., R. K. Rudel and G. D. Rose. Industrial Revenue Bonds: A Tool to Assist Rural Development. Circ. 689, Dec. 1972, SDSU Coop. Ext. Serv.

Kohloff, J. A New Method for the Rapid Isolation of Streptococcus from Water. M.S. Thesis, SDSU, 1973.

Lanham, O. E., B. G. Perry and R. M. Dimit. Conceptualization of Environmental Problems in the Big Stone Lake Area. Paper An. Mtg. Rural Soc. Soc., College Park, Md. Aug. 23-26, 1973.

Linder, R. L. and Y. A. Greichus. Tests on Learning Ability of the White Pelican. Proc. S. D. Acad. Sci. 51:132 (1972).

Madden, J. M. and J. N. Dornbush. Pollution Potential of Runoff from Production Livestock Feeding Operations in South Dakota. Rpt. Water Resources Institute, SDSU, 37 p., Apr. 1973.

Naeve, C. W. and G. C. Parikh. A Comparative Analysis of the Sequence of VEE and WEE Virus RNA Synthesis in *Aedes albopictus* Tissue Culture. (Abst.) An Mtg. Am. Soc. Micro. 1973.

Nothnagel, J. C. Comparison of Six Methods for the Quantitation of *Salmonella* species from Surface Water. M.S. Thesis, SDSU, 1973.

Smith, S. B. and D. C. Hales. Macroscopic Benthos Populations in Lake Poinsett, S. D. Proc. S. D. Acad. Sci. 51:182-194.

Steichen, M. E., D. R. Larson and G. C. Parikh. Western Equine Encephalitis (WEE) and St. Louis Encephalitis (SLE) Activity in Three Areas of South Dakota. (Abst.) An. Mtg. Am. Soc. Micro. 1973.

Wiebe, J. E. Water Quality Criteria—An Analysis as Applied to the Big Sioux River. Bull. 608, Apr. 1973, Ag. Exp. Sta., SDSU.

Objective 9—Provide information for improving the management talent and skill of homemakers.

Objective 10—Provide knowledge base for developing the recreational potential of South Dakota.

Food Habits of Deer in the Black Hills. (J. C. Schneeweis, K. E .Severson, L. Petersen for Northern Black Hills; T. E. Schenck, R. Linder, A. Richardson for Southern Black Hills). Bull. 606, Dec. 1972, Ag. Exp. Sta., SDSU.

Gartner, F. R. and K. E. Severson. Fee Hunting in Western South Dakota. J. Rng. Mgt., Vol. 25, No. 3, May 1972.

Hugghins, E. J. Parasites in Big Game. South Dakota Farm & Home Research, 23(4):(Winter 1972).

Severson, K. E. and F. R. Gartner. Problems in Commercial Hunting Systems: South Dakota and Texas Compared. J. Rng. Mgt. 25:342-345 (Sept. 1972).

Objective 11—Develop spring small grain varieties with higher yield capacities.

Albrechtsen, R. S. and C. D. Dybing. Influence of Seeding Rate upon Seed and Oil Yield and Their Components in Flax. Crop Sci. Vol. 13, Mar.-Apr. 1973.

Bonnemann, J. J. 1972 Standard Variety Small Grain Trials. Pl. Sci. Dept. Pamph. 10, SDSU.

Hovland, A. S. and C. D. Dybing. Cyclic Flowering Patterns in Flax as Influenced by Environment and Plant Growth Regulators. Crop Sci., Vol. 13, May-June 1973.

Price, P. B. Prilar Barley. Bull. 603, Oct. 1972, Ag. Exp. Sta., SDSU.

Reeves, D. L. Chief Oats. Bull. 610, May 1973, Ag. Exp. Sta., SDSU.

Objective 12—Develop new and/or more marketable products from agriculture produce.

Deethardt, D. Second-Day Dishes from Venison Roasts. Bull. 607, Apr. 1973, Ag. Exp. Sta., SDSU.

Spurgeon, K. R., S. W. Seas and B. K. Dalaly. Effects of Nonfat Solids and Stabilizers on Body, Texture, and Water Retention in Low-Fat Dairy Spreads. Food Prod. Dev. 7(3):34, 36, 43, 44.

——, —— and A. E. Gudeikis. Effects of Heat Treatment, Added Acid and Aeration on Storage Properties of a Low-Fat Dairy Spread. Food Prod. Dev. 7(5):104, 107, 108. 1973.

Schingoethe, D. J., G. L. Beardsley and L. D. Muller. Evaluation of Commercial Rapeseed Meal and Bronowski Variety Rapeseed Meal in Calf Rations. J. Dairy Sci. (Abst.) 56:683 (1973).

Stake, P. E., M. J. Owens and D. J. Schingoethe. Rapeseed, Sunflower and Soybean Meal Supplementation of Calf Rations. J. Dairy Sci. 56:783-788 (1973).

Uckert J. R. and D. J. Schingoethe. Partial Characterization of Animal Growth Inhibitors from Soybeans. J. Dairy Sci. (Abst. 56:622.

Objective 13—Develop low-cost, effective control of crop diseases and pests.

Arnold, W. E., and W. B. O'Neal. Canada Thistle Control in Corn. NCWCC Res. Rpt. 29:29-31 (1972).

—— and ——. Canada Thistle Control with Glyphosate and Metribuzin. NCWCC (Abst.) 27:53.

—— and ——. Canada Thistle Control with Metribuzin. NCWCC Res. Rpt. 29:28 (1972)

—— and ——. Downy Bromegrass Control in Established Alfalfa. NCWCC Res. Rpt. 29:19 (1972).

—— and ——. Herbicide Evaluation for Broadleaf Weed Control in Flax. NCWCC Res. Rpt. 29:68-70 (1972).

—— and ——. Japanese Chess Control in Native Pastures. NCWCC Res. Rpt. 29:13-15 (1972) and 27:46 (1972).

—— and ——. Pre-emergence and Post-emergence Corn Herbicide Screening. NCWCC Res. Rpt. 29:188 (1972).

—— and ——. Pre-emergence and Post-emergence Soybean Herbicide Screening. NCWCC Res. Rpt. 29:246-247 (1972).

—— and ——. Pre-plant Incorporated and Pre-emergence Corn Herbicide Screening. NCWCC Res. Rpt. 29:186 (1972).

—— and ——. Pre-plant Incorporated and Pre-emergence Soybean Herbicide Screening. NCWCC Res. Rpt. 29:246-248 (1972).

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SPECIAL SERVICES

DAIRY PRODUCTS ANALYSES

Analyses to assist processors and producers maintain quality of dairy products, and to assist research workers in the Dairy Science Department obtain research data.

Chemical	Analysis
Babcock	939
Mojonnier (solids)	304
Cryscope	12
Mojonnier (fat)	65
Acid degree value	14
Anhydrous butteroil:	
Free fatty acids	38
Fat	30
Curd	29
Peroxide Value	38
Total	1469
Microbiological Analysis	
Standard Plate Count	126
Coliform Count	113
Yeast and Mold Count	18
Wisconsin Mastitis Test	1
Antibiotics	2
Total	260

ANALYTICAL SERVICES

Analytical work done for residents of the state, other departments, other institutions or agencies by the Station Biochemistry Department include:

	Samples
Moisture	654
Protein	892
Ether extract	375
Crude fiber	165
Ash	117
Urea	13
Cereal or soybean on meats	79
Carotene on feed	37
Carotene on blood	50
Vitamin A on blood	51
Amino acids	68
Calcium	58
Phosphorus	61
Other minerals	54
Selenium	84
Arsenic	110
Mercury and lead	54
Prussic acid	8
Nitrate and nitrite	154
Strychnine	35
Pesticides	23
Miscellaneous	161
Total	3,303

SEED CERTIFICATION

The Seed Certification final report cannot be made before September 1, 1973 because the complete certified seed acreage is not known until that date.

SEED TESTING

The Seed Testing Laboratory of the Agricultural Experiment Station tests seed samples from four sources:

Service samples	3,576
Certification and Foundation	1,553
State Department of Agriculture	434
Research (estimated)	475
Total	6,038

CROP PERFORMANCE TESTING

The number of respective crops grown in 1972 were: spring-seeded wheats, 24; winter wheat, 17; spring triticales, 6; winter triticales, 1; rye, 8; barley, 13; oats, 26; alfalfa, 36; grain sorghum hybrids, 61; and corn hybrids, 215.

The 1972 variety trials were harvested at 10 small grain locations, 8 corn trial sites and 8 grain sorghum trial locations. Alfalfa stands were excellent going into the winter. The information obtained was used in evaluating newer releases and aided in making recommendations to farmers, ranchers, and others in agri-business in different areas of the state. Variety trials seeded for the 1973 crop year included the following: spring-seeded wheat, 28; spring triticales, 2; winter wheat, 25; winter triticales, 5; rye, 8; oats, 30; barley, 12; proprietary alfalfas, 36; grain sorghum hybrids, 63; and corn hybrids, 240. Small grains are at 9 locations; alfalfa, one; corn, 8 trials and 6 grain sorghum sites.

SOIL TESTING

The Soil Testing Laboratory tested and made fertilizer recommendations on approximately 1,600 soil samples sent in by farmers; 1,219 soil samples for research purposes; 405 plant samples for research purposes; and 10 plant samples for farmers. Six corn, six alfalfa, 12 small grains, three millet, five sunflower, and nine grass field plot experiments were established to evaluate fertilizer response and to be used in soil test correlations.

FOUNDATION SEED STOCK

The Foundation Seed Stock Division produces and maintains seed of superior genetic varieties as a service to certified seed growers for the benefit of South Dakota farmers. Foundation Seed increases in 1973:

Variety	Acres
Barley:	
Larker	40
Beacon	76
Flax:	
Nored	5
Summit	9
Linott	10
Sorghum:	
SD 102	3
Rye:	
Rymen	11
Yuma	2
Kodiak	10
Wheat:	
Chris HRS	20
Hard durum	20
Olaf HRS	60
Iowesta HRS	63
Minn. 64-33 HRS	12
Norana HRS	2
Winter Wheat	
SD 7117 HRS	4
Variety	**Acres**
RS 70H179	7
Oats:	
Astro	4
Froker	40
Chief	70
Dal	40
Ind. 6215 A20102 (Noble)	28
Burnett	35
Otee	5
SD 955	17
Ind. 5939 (Stout)	30
Multiline M73	10
Multiline E74	10
Soybeans:	
Chippewa	21
M 61-96	4
Corsoy	44
M 63-217Bf	11
Amsoy 71	12
Wells	30
Grasses:	
Oahe intermediate	9
Pierre side oats	2
Lodorm green	1
Alfalfa:	
Travois	24
Corn:	
Single cross	48
Inbred	26

HOW LONG DOES IT TAKE?

Despite recent technological advances we are yet unable to transform new ideas into successful products more quickly, according to a study by the Battelle Columbus Laboratories as reported in *Parade* magazine.

Stressed throughout the report, that examined 10 innovations for the National Science Foundation, was the importance of what was termed the "technical entrepreneur" who persists in the face of various inhibiting effects.

The following provides an idea of the time-frame as calculated for various innovations, including several of direct relation to agricultural research:

Innovation	Year of First Conception	Year of First Realization	Duration, years
Heart Pacemaker	1928	1960	32
Hybrid Corn	1908	1933	25
Hybrid Small Grains	1937	1956	19
Green Revolution Wheat	1950	1966	16
Electrophotography	1937	1959	22
Input-Output Economic Analysis	1936	1964	28
Organophosphorus Insecticides	1934	1947	13
Oral Contraceptive	1951	1960	9
Magnetic Ferrites	1933	1955	22
Video Tape Recorder	1950	1956	6
Average Duration			19.2

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